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BRIEFLY TOLD.

THANKSGIVING TIME.—Those interested in the gas business of America have much cause for uniting in an expression of hearty thanksgiving over the existing conditions governing their trading. From all quarters we have positive proof that a healthy growth in output is going on, which growth has been especially vigorous in respect of the last two weeks in October, and through the month of November—of course, the comparisons are made between the corresponding times of 1899 and 1900. During the past summer there was some slight shrinkage in output as compared with the summer of the preceding year, but the reasons for such shrinkage were so plain that the real wonder is that the decrease was not more marked. The doubt as to the outcome of the Presidential election (for nothing can be considered accomplished until the result is known), while small, was nevertheless sufficient to curtail trading in all industrial lines, and the gas men suffered with the rest on that score; but the really potent factor in shrinking the send-out in the past summer season was the abnormally protracted, excessive atmospheric temperatures which prevailed, especially in and over the Atlantic seaboard. In fact, were it not for the widespread use of gas for cooking in that region the output returns would have been strikingly discouraging. However, taken as a whole, the fraternity have little cause for other than thanksgiving over the output returns for the first 10 months of the year; for our figures in that respect, from 38 test points, and obtained in the usual way, show a gain that averages 9.24 per cent. over the figures from the same places in the corresponding months of 1899. The total output from the 38 points was something over 10,000 millions cubic feet. The financial outlook, too, is considerably better as a whole than was the case in 1899, if one may judge by the appreciation on the average of the values of shares. And in this estimate no notice is taken of the increase in the quoted worth of New York city gas shares, which less than a year ago were strongly affected by the gigantic gas war then being waged. Indeed, if for no other reason, the fraternity at large have much cause for thankfulness in the knowledge that a satisfactory settlement of this disturbing condition was reached between Thanksgiving times; for certainly no one may truthfully say that the New York rate and survival contest was not a serious, if not menacing, matter to everyone connected with the gas business of America. Under the circumstances, however, a conflict was inevitable, so perhaps it is well that it was fought to a finality, and as out of trouble good may come, with the ending of the contest comes the knowledge that in as short a time as possible the combined companies will be the possessors of the largest and most complete gas works in the world. This works is to be located at Astoria, Long Island, and the plans for its construction are virtually completed. The gas men again have additional cause for thanksgiving in knowing that the demands of sellers of all kinds of material that enter into plant construction and maintenance and into actual manufacture of their product are inclined to the decreasing side, a state of affairs that has wonderfully stimulated inquiries for works' renewals and extensions for the coming year. So it is with cheerfulness that we join with the fraternity, whom we endeavor loyally to support, in an expression of heartiest thankfulness for the successes of the year and of grateful expec-

tancy for further positive advance as outlined by the appearances of to day.

PERSONAL.—Mr. and Mrs. A. W. Littleton arrived in New York, after their lengthy European wanderings, last Monday, en route for their Quincy (Ills) home. Their stay abroad was running well into the third year, and the genial, hearty "Gus." that he is, now wonders how it was possible he could remain away so long from what he stoutly avers is "God's Country." Well, if he's glad to be home it is a certainty that we are all glad to have him home.

OBITUARY NOTE.—MR. HERMAN WILKIEMEYER.—The JOURNAL for last week contained a brief notice of the death of Mr. Herman Wilkiemeyer, Vice-President and General Manager of the Evansville Gas and Electric Light Company of Evansville, Ind., whose demise occurred in Cincinnati, Ohio, the morning of November 20th. He had gone to Cincinnati some time ago, for the purpose of putting himself under the care and direction of specialists for the treatment of the dis order from which he suffered, chronic Bright's disease. Herman Wilkiemeyer was born in Newport, Kentucky, October 18th, 1852. Having completed a collegiate education he became a teacher, but the routine or confinement thereof was unsuited to his temperament. An opportunity to become connected in a business way with the Lancaster (Ohio) Gas Light Company was availed of, and in a comparatively short time his practical knowledge of its business caused his promotion to the superintendency thereof. Not long afterwards he accepted the dual position of Secretary and Superintendent to the Portsmouth (Ohio) Gas Light Company. In performing these duties he attracted the attention of the proprietors of the Evansville (Ind.) Gas and Electric Light Company, who offered him the position of Superintendent. He began his active work there July 1st, 1891, and so well did he serve the Company, that in 1893 he was elected its Vice-President and General Manager, which positions he filled with perfect satisfaction to the Company and with credit to himself. He was a strong believer in the benefits accruing to the industry through Association work. He was a charter member of the Ohio Gas Light Association, and served it in many ways, as a committeeman, an executive officer and as a contributor of papers. In 1892 (8th annual meeting) he presided over its deliberations, having been elected its President at the preceding meeting. He was elected to membership in the Western Gas Association at the 12th annual meeting thereof, Cincinnati, Ohio, May, 1889, and he also served the Western with that zeal which marked his affiliation with the Ohio Association. While all of his papers were marked with study and by a true appreciation of the nature of the theme treated, and accordingly were of real value to the industry at large, it is likely that those which attracted the most attention were: "Methods of Taxation of Different Gas Companies, and a Comparison of the Same," read at the 5th annual meeting of the Ohio Association (Mansfield, 1889), and his address as President of that body. Personally, he was of the type and nature that made friends and hold them, and his untimely taking off is a severe loss to the profession that he so harmoniously and capably aided, and a grievous blow to a legion of friends. He was a devout, practicing member of the Catholic faith, being an active factor in the Church of the Assumption, of Evansville. He is survived by his widow, and three sons. His father, two brothers and a sister also survive him. The interment was made in Four Mile Cemetery, Newport, Ky., November 23d.

OBITUARY NOTE.—MR. DONALD LOUIS CATHELS.—It is with great regret we record the death, on Nov. 21, of Mr. Donald Louis Cathels, Assistant Engineer and Superintendent of the Louisville (Ky.) Gas Company. The following sketch of his life was written by one who knew him well: "He had been ailing for some time, but changes that have been going on in the works prevented him taking necessary rest for recuperation. He took to his bed a few hours before his death, which occurred the afternoon of Wednesday, Nov. 21st. He leaves to mourn his loss a wife and young son and daughter, also three brothers: Mr. William M., Manager of the Brantford (Ont.) Gas Company; Edmund, Engineer and Manager, Hamilton (Ont.) Gas Light Company; and B. S. Cathels, who is connected in business with his brother Edmund. He also leaves two sisters, residents of Glasgow, Scotland. Donald Louis Cathels was comparatively a young man, being only 44 years of age. He was of sterling qualities, unassuming and of a lovable nature, and thoroughly practical in all branches of the business he followed. For the past 12 years he held the same position with the Louisville Gas Company, and previously was connected with the Chicago Gas Light and Coke Company. He was born to the gas business, having been a son of the late E. S. Cathels, so well known to the gas fraternity. The funeral was conducted from his late residence in Louisville, and the attendance thereon and the tokens sent were strong evidences of the regard in which he was held by those to whom he was known."

The Incandescent Gas Mantle and Its Uses.

[The last of a Series of Cantor Lectures, delivered before the Society of Arts, London, England, by Prof. Vivian B. Lewes.]

The history of the incandescent mantle has not been altogether devoid of attempts to introduce forms suitable for flames other than those given by the Bunsen burner with a circular tube. First and foremost amongst these in the inception of incandescence came the Fahnehjelm comb, made of a number of thin magnesia rods, set in a back of fireclay, supported by an iron frame clamped above a small Bray burner, in which water gas was consumed. The comb, however, as has been before stated, burnt away in less than 100 hours owing to the volatility of the magnesia, whilst the light which it emitted even in its prime only amounted to 3 or 4 candles per cubic foot, although it was afterwards found that dipping in a solution of chromic acid brought this up to nearly double value, and increased fourfold the life of the burner.

When the idea of making a fabric was firmly established and the mantles began to be a success, De Mare tried to utilize the flat flame as a source of heat in which to excite a fringe of fabric soaked in a mixture of the salts of the rare earths and burnt off so as to give a comb of very fine oxide filament. The effect produced by this when properly arranged was extremely good. In the burner employed for this purpose he first tried what was practically a flat flame Bunsen, which gave very good results, and later he employed a burner in which the coal gas *per se* was forced out into the air in so thin a sheet that the hydrocarbons in it became thoroughly consumed, and a non luminous flame was produced. It was possible to do this in Paris as the gas supplied was only 14 candles, and the pressure at which it was distributed 4 to 5 inches, so that by using a very small Bray nipple a thin non-luminous flame was produced, which, owing to the admixture of air being only just sufficient to give the desired effect, was hotter than the flat Bunsen flame. It was attempted to introduce these De Mare plumes into England, but the rare earths employed were held to be the equivalent of the earths protected in Welsbach's 1885 patent.

Another very effective variety of incandescent is to be found in the De Lery burner and its cluster of baby mantles or tassels. Taking a Bunsen burner with a dome top, in the sides of which holes were pierced at regular intervals, De Lery obtained a circle of small Bunsen jets, each of which raised to incandescence a small tassel of the oxides of thorium and cerium. These tassels were suspended from a twelve armed circular support, and hung in the corresponding number of flames issuing from the top of the burner. The effect given is most excellent, as the spreading of the incandescence over a considerably larger surface prevents the irritation of the eye so prevalent with the ordinary mantle, whilst the diffusion of light obtained in the room is distinctly superior.

I have already on more than one occasion pointed out the great difference which exists between the measurement of illuminating power as carried out on the photometer, and the illuminating effect which one obtains from illuminants in practice. The De Lery tassel burner is as good an example of this phenomenon as can be found, for, although it gives less light than the ordinary incandescent mantle, when tested at the horizontal in the photometer, its illuminating effect is far superior, and the light, being mostly cast in a downward direction, illuminates the surface below the burner, whilst with the ordinary mantle the bulk of the illumination is thrown from the horizontal upwards, owing to the form of mantle being a cone. These burners with their tassels have proved very successful in America, and I am informed that they will shortly be introduced into this country, when their novelty of appearance and excellent effect will undoubtedly go a long way towards making them a success.

Attempts have also been made to strengthen and increase the amount of light obtainable from the ordinary shape of mantle, a noticeable endeavor in this direction having been made by Plaissetty, who noticing the great intensity of heat produced over the small area immediately above the burner top and the tendency which mantles had to shrink at this spot, attempted to both strengthen the mantle and increase its light emissivity by braiding the mantle with clocks or seams of the same incandescent material as that of which the mantle itself was composed. The result, however, did not give promise of any very great increase in illluminating power, and the idea has been, I believe, abandoned. Plaissetty also made mantles consisting of plaited bands of ropes, each perfectly distinct from the other, which were hung from a central support around the mantle head, and which could be burnt off by the consumer, as no shaping was required.

Leaving now the subject of the mantle which is heated to incandescence, let us pass on to the burners which have from time to time been improved and altered in order to give the highest attainable candle power from the incandescent mantle.

It was Davy who first showed that when a jet of coal gas is allowed to pass under pressure from a small orifice and is then burnt upon the surface of a piece of wire gauze held an inch or two above the exit pipe, the flame is kept from flashing back to the exit owing to the high conducting power of the gauze, and it becomes non-luminous, a result which he correctly ascribed to the gas mingling with the air in its upward passage. As he supposed, the combustion of the carbon is so rapidly completed as to prevent the presence of any solid particles that could be heated to incandescence. The concreting of this idea into the burner that has done so much for the utilization of gas as a fuel and an illuminant is due as I have shown to Roscoe and Bunsen, and simple as the adaptation was, it forms a link in the chain that supports the great gas industry even more important than Welsbach's valuable discovery.

In the early form of burner made by Bunsen the gas issued from either a flat flame or an Argand burner head into a metal cylinder open at the bottom and closed at the top by means of a disk of fine wire gauze, so that the gas issuing from the burner head passed upwards through the air in the cylinder, and mixed with it, the mixture burning on the top of the gauze. The difference between this class of burner and those which succeeded it was that the uprush of the gas with its mingling with the air was due simply to the velocity with which it left the burner and to the fact that the specific gravity of the gas is less than half that of air.

Very soon, however, it was found that a more rigid flame and one more easily under control could be obtained by utilizing the pressure under which the gas was delivered at the burner to produce the effect of an injector. Then the uprush of the gas drags in air through side holes arranged at the bottom of a vertical burner tube placed above the gas nozzle. In order to do this a small jet or series of orifices discharged the coal gas into a small chamber surmounted by the upright burner tube, and either the walls of the chamber or the lower portion of the tube were perforated with an opening or openings in connection with the air. On opening the gas tap the coal gas is discharged through a jet with a velocity dependent upon the pressure of the supply, and rushing upwards and impinging upon the sides of the tube above, it acts in the same way as the steam in a Giffard's injector. By drawing up from the chamber the air which is present there it forms in it an area of low pressure, and so sucks in more air through the lateral holes to re establish equilibrium, this action continuing, and the formation of the mixture of gas and air in the tube going on as long as the gas continues to flow.

In this arrangement it is manifest that by regulating the size of the hole in the gas jet and the lateral air holes, it is possible to adjust the mixture of air and gas formed in the tube with the greatest nicety, and to obtain a perfectly non-luminous and fairly rigid flame at the top of the burner.

After burners, however, have been in use for some time, no matter how well they may be regulated at first, the partial stoppage of the injector tip by dust particles and other causes acting upon the jet and air supply, frequently derange the ratio of the two supplies, and the result is that in a laboratory or other place where a large number of Bunsen burners are used, a wide discrepancy can be noticed in the flames given by the burners. In some the gas is burning with a slightly luminous top, and the inner zone is barely visible; in others the normal conditions exist, and you have a well marked violet inner zone and a non-luminous lilac outer zone; in others, again, the flame is somewhat shortened, showing a distinct greenish tint in the inner zone, with a pale lilac outer zone, and it is generally found that when this point has been reached the flame has more or less a tendency to roar, and will flash back in the burner tube and ignite the gas as it issues from the jet.

These appearances all mark different ratios between the air and gas in the mixture passing up the tube. When one sees a slightly luminous tip, it means that the gas is mixed with less than twice its own volume of air, whilst with the normal conditions obtained with the ordinary 16-candle gas, one volume of gas is drawing in 2.2 volumes of air, the violet inner zone begins to show a tendency to turn to green when the ratio has become 1 of gas to 2.3 of air, whilst another tenth of a per cent. causes the green to become most marked and the roaring to commence.

With the ordinary Bunsen burner, as used in the laboratory, it is not possible to push the admixture of air and gas beyond this point, as the admixture of air and gas in the tube is now explosive, and the flame is only prevented from flashing back to the jet below by the rate of propagation of the explosive wave being less than the upward rate of flow of the mixture, and any further increase in the quantity of air present increases the rate of the explosive wave, and so causes flashing back. If, however, the head of the burner tube be covered with a layer or layers of fine wire gauze, the power of conduction which the fine metal filaments possess, and the fact that they reduce slightly the area of the tube, and so increase the rate of flow through the orifices of the mesh, prevents the downward propagation of the wave, and under these conditions the ratio of air to gas can be raised to over 3 volumes of air to the 1 volume of gas, and the green zone shrinks down on to the surface of the gauze, and shows itself as a seething layer, in which the green color has reverted to a very pale blue.

The importance of the regulation of the ratio between the gases having been recognized, the air holes in most of the burners used for laboratory and heating purposes were then fitted with cut off rings, consisting of loose rings of metal with holes in them, which could be slid round over the holes in the side of the chamber, so that when the two sets of holes coincided the full air supply could be obtained, whilst by drawing the solid metal of the ring more or less over the under holes, the area of the air supply could be reduced. In this way it was possible to adjust the condition of the flame to the work required of it.

It will be evident that it is the admixture of air with the coal gas before combustion that causes the production of a non-luminous flame, and the old theory to account for this phenomenon was that the oxygen burnt up the hydrocarbons in the gas before their decomposition set free any solid particles of carbon to render the flame luminous. Knapp and others, however, showed that oxygen was not necessary for the production of a non-luminous flame, but that the luminosity could be destroyed by diluting the gas before combustion with such non inflammable and inert gases as nitrogen, carbon dioxide and steam, and the experiments of Blochmann, Landolt and Heumann showed that nitrogen played a most important part in the action.

Some years ago I attempted to ascertain the relative importance of the oxygen and nitrogen in rendering the flame non-luminous, and for this purpose I employed a Bunsen burner, fitted at the bottom of the tube with two supply pipes instead of the ordinary gas jet and lateral air holes. Each pipe was connected with a small meter, so that the flow of gas and air could be measured. The first determination was the quantity of air that was necessary to render the flame non-luminous, and it was found to require 13.5 volumes of air for 6 volumes of gas; 13.5 volumes of air contain roughly 2.7 of oxygen and 10.8 of nitrogen.

When 6 volumes of coal gas were passed into the burner with 10.8 volumes of nitrogen, a flame was obtained which had only a slightly luminous tip, whilst with 2.7 volumes of oxygen to 6 of coal gas a luminous flame was obtained which flashed back unless the burner was provided with a gauze top.

A Bunsen burner burning coal gas alone gave on the photometer with 5 cubic feet per hour 5.6 candles, but with the addition of 2.2 cubic feet of oxygen 3.1 candles; using nitrogen, however, in the proportion of 9 cubic feet to 5 cubic feet of gas, the luminosity was so feeble that it could not be read. It follows, therefore, that the amount of oxygen in the air necessary to destroy the luminosity does less than one-half the work. Accordingly another experiment was tried with varying amounts of oxygen, the results being as follows:

	Candle Power.
5 cubic feet of gas alone.....	5.6
5 " " to 1.1 cu. ft. oxygen	5.4
5 " " 1.5 " " ..	8.0
5 " " 2.2 " " ..	3.1 gauze used.
5 " " 2.5 " " ..	0.0

The next determination to be made was the amount of nitrogen that was needed in order to bring about complete non-luminosity by dilution only. Nitrogen was supplied to a coal gas flame burning at the rate of 6.2 cubic feet per hour, and it was found that 14.2 cubic feet per hour of nitrogen were needed to effect this result, an amount which is practically the same as that of the air required before.

1 volume of gas required 2.30 volumes of nitrogen.
1 " " 2.29 " air.

This seems to show that the oxygen acts merely as a diluent, but if this were so then mixtures of oxygen and nitrogen containing a larger percentage of oxygen than ordinary air should have the same effect on the luminosity of the flame as air, but this is disproved by the following results:

Volumes of Varying Mixtures of Oxygen and Nitrogen Required to Render 1 Volume of Coal Gas Non Luminous in a Bunsen Burner.

Gas. Vol.	Vol. of Mixture Required.	Composition of Mixture. Nitrogen.	Oxygen.	Vol. of Oxygen Present in Amount Required.
1	2.30	1	nil.	nil.
1	2.30	5	1	0.38
1	2.27	4	1	0.45
1	2.02	3	1	0.50
1	1.49	2	1	0.50
1	1.00	1	1	0.50
1	0.50	nil.	1	0.50

From this it will be seen that until the percentage of oxygen reaches the amount present in air, the diluting influence of the nitrogen over powers the effect of the oxygen in the destruction of the luminosity, but with 25 per cent. and over of oxygen the retarding influence of the nitrogen has no effect on the activity of the oxygen.

The effect of various gases in bringing about non luminosity was then tried, but the employment of a wet meter for measuring purposes rendered the number of these limited.

Volume of Gases Required to Render 1 Volume of Coal Gas Non-Luminous.

1 vol. coal gas requires	0.50	vol. of	oxygen.
" " "	1.26	"	carbon dioxide.
" " "	2.27	"	air.
" " "	2.30	"	nitrogen.
" " "	5.11	"	carbon monoxide.
" " "	12.40	"	hydrogen.

So that a combustible diluent which increases the temperature of the flame is required in far larger quantity than a non-combustible diluent in order to render the flame non-luminous.

The varying effects of diluents have been attributed to the influence of density, but it has been shown by Heumann that a flame can be rendered non-luminous by cooling as well as by dilution. If a luminous flame be caused to spread itself over a cold surface it became non-luminous, but the luminosity could be restored by heating the surface over which the flame plays. If, therefore, a diluent had the power of extracting more heat from a flame than another it would be more active in reducing the luminosity, so that a smaller quantity would be required to render the flame non luminous, and on comparing the specific heats of the gases used in the last experiment the reason for the small quantity of carbon dioxide is at once seen.

Specific Heats of Equal Volumes.

Oxygen	0.2405
Carbon dioxide	0.3306
Nitrogen	0.2370
Air	0.2374
Carbon monoxide	0.2370
Hydrogen	0.2359

Experiments show that this is in all probability the true explanation, as in the flames rendered non luminous by diluents, the inner cone for the first 1¼ inch is decidedly cooler than in the luminous flame, owing to the cooling action of the nitrogen or carbon dioxide. Above this point, however, the influence of the oxygen begins to be felt, and the non-luminous flame is here hotter than the luminous flame, whilst the hottest portion of the flame is to be found half way between the tip of the inner and outer cones. With inert diluents, however, the hottest points are found at the side and tip of the outer cone when the air necessary for the combustion is obtained.

With a Bunsen burner, in which the mixed gas and air give a green inner cone, although a low temperature, due to the excess of air, is found at the bottom of the inner cone, yet the increased quantity of oxygen causes a rapid oxidation in the upper portion and a smaller and hotter flame is produced.

From these experiments and also from the researches of Heumann it will be seen that several causes aid in the destruction of luminosity in a flame, chief amongst which are oxidation, dilution and cooling.

The chemical changes taking place in a Bunsen flame are far more simple than those which are going on in the luminous flame. Taking the ordinary London coal gas having the composition:

Hydrogen	52.16
Unsaturated hydrocarbons	3.50
Saturated hydrocarbons	36.25
Carbon monoxide	3.68
Carbon dioxide	0.09
Nitrogen	4.10
Oxygen	0.31
Sulphuretted hydrogen	0.00
	100.00

We find that a gas of this composition requires about 5.0 times its own volume of air for its complete combustion. When a Bunsen burner burns with a blue non-luminous flame, the ratio of gas to air is about 2 to 1, less than half the amount necessary to complete combustion, whilst with the green inner cone 2.5 of air mix with 1 of gas, so that the Bunsen flame obtains from the mixture only about one half the air necessary for its complete combustion, the remaining portion being obtained from the exterior of the flame during combustion. This is the cause of the double cone in the flame, the inner cone being formed by the incomplete combustion of the gas with the admixed air, and the outer cone by the combustion of the products of this incomplete combustion by means of the external air. This can be proved by the use of an apparatus devised by Mr. Lewis T. Wright and perfected by Professor Smithells, in which the two parts of the flame can be separated. This dual action is practically complete when the ratio of air to gas is 2.6 to 1 and the green cone is produced, and the action of the mixture in the inner cone may be approximately expressed by the following equations:

Hydrogen. Oxygen. Water.

$$H_2 + O = H_2O$$

Ethylene. Oxygen. Carbon Monixide. Water. Hydrogen.

$$C_2H_4 + O_2 = 2\,CO + H_2O + H_2$$

Methane. Oxygen. Carbon Monoxide. Water. Hydrogen.

$$CH_4 + O_2 = CO + H_2O + H_2$$

The resulting carbon monoxide and hydrogen in about equal proportions diluted with twice the quantity of steam and the unchanged nitrogen burn at the expense of the oxygen of the external air forming the outer cone. A small quantity of carbon dioxide is also always found, probably due to the oxidation of some of the carbon monoxide by the steam, and the gaseous mixture which forms the outer cone has an approximate composition of:

	Per Cent.
Water vapor	16
Nitrogen	60
Carbon monoxide	9
Hydrogen	10
Carbon dioxide	5
	100

It does not seem possible that such a mixture, containing as it does less than 20 per cent. of combustible gas, should burn and produce the intense heat found in the outer cone of the Bunsen burner, but Professor Smithells has shown that under ordinary conditions the heat of the inner cone is added to that of the outer, so that in the combustion the outer cone is always hotter than the inner.

That this is so can be clearly shown by using the Smithell tube, and having widely separated the two cones of the flame, holding a mantle in the outer zone. The mantle is not then heated to incandescence, but on now allowing the inner cone to rise in the tube, the mantle becomes more and more luminous until the zone has resumed its proper position in the center of the flame, when the mantle gives its full incandescence.

It is quite clear that the ratio of gas to air needed to give the best results in a Bunsen burner intended for use with an incandescent mantle must be the one which yields the hottest outer zone to the flame, and it might be expected that this would be arrived at by only just allowing sufficient air to mingle with the gas to render it non luminous, as there is then a larger proportion of combustible gas to burn at the surface of the mantle, and one might expect a higher temperature at that point. This, however, is not the case, as the heat from the combustion in the inner zone can only escape through the outer zone, and the maximum effect on the mantle is produced when, as nearly as possible, one-half the combustion takes place in the inner zone at the expense of the air drawn in with the gas through the air holes of the Bunsen, whilst the second half is burnt on the surface of the mantle itself.

This was proved experimentally by closing the air holes, removing the injector from a mantle burner, and fitting in its place a T-piece, through the arms of which the gas and air measured by the standard meters were passed. The gas supply was kept constant at 5 cubic feet per hour at a pressure of 1.5 inches of water, and the air regulated to give the desired appearance to the flame. The rate of flow of gas and air was when taken, and a well fitting mantle placed on the flame, the illuminating power ascertained, and a Le Chatelier thermo couple placed so that the twist just touched the mantle at a point one inch above the burner head. Every precaution was taken to ensure accuracy, and the results were as follows:

Condition of Flame.	Ratio of Flow. Gas.	Air.	Ratio. Gas.	Air.	Candle Power per c. ft. of Gas.	Temperature °C.
Under Aerated.....	4.3	10.0	1	2.2	14.4	1,880
Best Aeration.....	4.5	12.75	1	2.75	20 0	1,915
Over Aeration.....	4.5	15.25	1	3.4	17.7	1,905

On analysis the gas was found to contain :

Hydrogen	60.4
Saturated hydrocarbons	28.1
Unsaturated hydrocarbons	4.0
Carbon monoxide	5.0
Carbon dioxide	0.0
Oxygen	0.5
Nitrogen	2.0
	100.0

And by exploding with oxygen it was found that for its complete combustion 1 volume of gas requires 5.5 volumes of air.

From this experiment it is clear that there is a point in the aeration of the Bunsen flame which gives the highest temperature in that portion in which the mantle is situated, and that above or below this ratio the light yielded by the mantle suffers.

Experiments were then made to determine the effect upon the light emitted by the mantle of different degrees of aeration, the arrangement of the apparatus being such that the burner could suck in the air it needed in the usual way from a tubulated globe, the gas being burnt at a constant rate under a pressure of 1.5 inches of water, whilst the flow of air could be varied. The result shows that with a 16 candle gas, on increasing the aeration, the candle power of the mantle steadily rises until a maximum is obtained with a little more than one half the amount of air required for complete combustion, whilst on increasing the aeration above this point, the candle power steadily fell.

A serious trouble with mantle lighting is the carbonization of the mantle, which commences with a slight sooty deposit at one spot, and then rapidly grows over the surface of the mantle, not only reducing the light emitted but giving rise to traces of carbon monoxide in the products of combustion.

When the flame is under aerated and contains a ratio of less than 2.2 volumes of air to 1 of gas, some methane escapes combustion in the inner zone of the flame and burns with the carbon monoxide and hydrogen in the outer flame, and it is this which causes the trouble.

On replacing the ordinary tube of a Bunsen burner with one made of platinum, and if the ratio of gas and air be so arranged as to give a blue non-luminous flame, on heating the platinum tube the flame becomes luminous, although not to such an extent as would have been obtained from the original gas. If the tube be allowed to cool down the flame again becomes non-luminous, showing that the luminosity is due to the restoration of heat to the flame and not to any alteration in the composition of the gas. But with a Bunsen burning with a green inner cone, luminosity cannot be produced by heating the mixture of gas and air. On now taking an ordinary Bunsen with a brass tube and surrounding the blue non-luminous flame with a platinum gauze mantle open at the top, and so arranged that the sides of the flame heat the mantle to a high temperature, the top of the flame will become luminous, owing to the platinum superheating the flame gases from the inner cone and causing them to decompose with separation of particles of carbon. The same result is obtained with an ordinary mantle open at the top, and it is to this cause that the deposition of carbon on the mantles is due.

It will often be found that the carbon begins to deposit on the rod which supports the mantle, and is fixed in a small plate in the burner head. Above this plate there is a zone of unburnt gas which is raised to a high temperature by the radiant heat from the walls of the mantle, and the same conditions as before for the deposition of carbon are brought about. When once this carbon has started to form, its catalytic action causes the decomposition of the hydrocarbons still present to proceed with greater rapidity, so that in time both the upper part of the rod and the mantle become so crusted with carbon as not only to reduce the light emitted to a minimum, but to cause the formation of distinct quantities of carbon monoxide in the products of combustion.

The amount of air needed to give a non-luminous Bunsen flame varies with the richness in hydrocarbons of the gas, and the higher the candle power the greater must be the volume of air used for each volume of gas. It is found by experiment that although the increment in the volume of air needed for each extra candle power in the value of the gas is fairly constant for gases below 20-candle power, it rapidly rises when richer gases are used. The candle power of the original gas also affects the light which is to be obtained from the mantle.

If an ordinary burner and mantle be purchased, and tested first with 16-candle gas then with 15, and finally with 14-candle power gas, it is often found that it gives a better light with the 15 than the 16, and a further improvement with the 14-candle gas. This, however, is dependent upon the fact that the burner is drawing in less than the necessary amount of air to give the best conditions of combustion in the inner zone, and that the right degree of aëration is being more and more nearly approached with the poorer gas, When care is taken to ensure the correct ratio of air and gas consumed in each case, it is found that for qualities of gas between 14 and 18-candle power there is a gain of about 3 per cent. in the light emitted by the mantle for each candle illuminating power in the gas.

When Welsbach first introduced the incandescent mantle, the burner which he used consisted of a small Bunsen burner of the ordinary type, with a tube of about the same length as in an ordinary laboratory Bunsen, on to which was fitted a gallery to carry a chimney and a head stamped out of thin sheet metal. The length of the fitting was, however, objected to by consumers, who had up to that time only been accustomed to screwing a flat flame or Argand nipple on to their fittings, so the burner tube was very soon shortened, and the head carrying the gallery which fitted over it was made so that it slightly increased this length.

Many forms of these burners have been used, the differences being chiefly dependent upon the construction of the head, some consisting of open circular slots, others of flat gauze disks with a small baffle in the center, some having gauze domes, others steatite or cut metal tops. But owing to the construction of the burner, they all had one peculiarity, and that was they under aërated the gas before combustion, and, in consequence, a chimney was required with them in order to create an up draught, and to bring air rapidly in contact with the burning gas on the surface of the mantle.

When no chimney was used the unburnt gas from the inner zone had to travel a small distance from the surface of the mantle, through which it was passing before it obtained the necessary air for its combustion, hence the layer of highest temperature was outside the mantle, which, in consequence, was not raised to the highest degree of incandescence; but when the chimney was put on the uprush of air that it created burnt the escaping gas on the surface of the mantle itself, and the best results were obtained. Burners of this class are still those most used, and it is now fully realized that if the amount of air sucked in by the burner is not at least one-half the total volume of air needed for the complete combustion of the gas, a chimney of such length as to create a sufficient draught to consume all surplus gas on the surface of the mantle must be used. Taking a 14 or 15 candle power gas, a 6-inch chimney is generally sufficient to supply the necessary air, whilst with a rich gas, such as is supplied in Edinburgh, a 10 or 12-inch chimney is not too long for the work it has to do.

It is now beginning to be found that the chimney even is capable of improvement, and that if instead of allowing all the air to be drawn up from the bottom, holes are made in the chimney just above the level of the burner head, the air impinges more directly on the mantle and a slightly better result is attained. The idea, originally due to Sir Edward Frankland and revived every few years since, of heating the air supply by making it pass down between an outer glass and the chimney before ascending the interior of the chimney itself has also been applied to mantle burners, but unless very carefully adjusted, the loss of light due to absorption by the glasses nearly makes up for the slight gain.

Mantle burners in which regeneration has been attempted have also been tried, but the fact that the air or gas can be heated separately, and then utilized to give a very hot flame, does not apply to the mixture of the two, as when a mixture of air and gas is heated, oxidation of the gas commences, and the loss of combustible matter due to this cause outweighs the advantages of pre-heating.

Real improvements in the burners employed in mantle heating commenced in the early nineties, and at this period Chemin and Bandsept both began working at the idea of adding air to the gas in small portions so as to gain a more intimate mixture of the two before combustion. Chemin's burner however was never a practical success, but Bandsept succeeded in producing a burner which up to the present time has never been excelled. Using a conical injector of such a character as to spread the jet of gas issuing from it, he placed above it a short truncated cone which upwardly converged in such a way that the area of the upward flow of the jet of gas practically filled it; above this again he placed another cone of the same character having a still

wider opening at the top. Several of these ever widening cones being used and a suction being created in each, air was allowed to be drawn in through small holes in the base of the cones, and mingling with the upwardly flowing stream of gas and air entered a larger upwardly diverging cone which acted as an expansion cone and relieved the pressure that otherwise would have been created by expansion on nearing the heated burner head. The gases were finally mixed by passing through atomizers consisting of double layers of wire gauze, perforated metal thimbles, or other devices, which would complete the admixture of the air and gas immediately before combustion.

The work done by Bandsept in perfecting the Bunsen for mantle heating was enormous, and on glancing back through his Belgian patents one finds that nearly every feature of such modern burners as the Kern had been worked out by him before 1896. His burners are still the best that have been introduced and are indeed the form of chimneyless burner adopted by the French Auer Company.

In 1894 De Mare made a number of different forms of burner for his plumes and for mantles, and improved the suction given by his jet of coal gas, by placing above it a tube having the form of two cones united at their summits. This largely increased the uprush of the mixture and also added slightly to the amount of air drawn in with the gas. The so called "Simplex" burners, which are now largely used, are made upon the principles enunciated by De Mare in his patent.

In the burners made upon the principles first put forward by Bandsept and De Mare, owing to the superior rigidity of the flame due to the increased rate of outflow of the mixture and the aëration being brought up to the best point for exciting the incandescence of the mantle, the chimney can be dispensed with.

Perhaps the best known chimneyless burner at the present time is the highly vaunted Kern burner, in which the form of head devised by Bandsept in one of his earliest patents is added to the suction tube formed of truncated cones patented by De Mare, giving a burner which yields practically the same photometric results.

It must always be remembered that the statement of illuminating power yielded by various incandescent mantles and burners is always open to the interference of several important factors, the chief one amongst which is fit of the mantle. Most observers seem to imagine that so long as the mantle will go over the burner head, and the rod that supports it is of the prescribed height, the full illuminating power which the burner and mantle are capable of yielding is given. This, however, is an entire mistake, as unless the mantle not only fits the head, but also the flame perfectly, serious discrepancies at once arise; and although when a perfectly fitting mantle is obtained such chimneyless burners as I have described will give as high as 24 candles per cubic foot of gas consumed, they are just as often found to give 14, and if the burners and mantles commercially sold be taken and tested carefully, the average comes out at about 18 or 19 candles per cubic foot of gas. Until absolute uniformity in the construction of the burner and in the shape of the mantle can be obtained these discrepancies cannot be avoided, and it is only by taking the greatest possible precautions that fair results can be obtained.

I cannot help thinking that manufacturers make a great mistake in claiming illuminating powers for their mantles and burners which have only been obtained in isolated cases where by chance perfect conditions have been attained, as the non-fulfilment of these results in practice gives rise to disappointment to the consumer, and discredits the particular form of burner.

In conclusion, I can only regret that the shortness of the course has prevented me from dealing with a large number of points which otherwise I would have liked to touch upon.

Difficulties in the Construction of a Concrete Gasholder Tank.

[A paper read by MR. F. G. COCKEY, at the meeting of the Southern District Association of Gas Engineers and Managers, High Holborn, London, England, Nov. 15th.]

In accepting the Hon. Secretary's invitation to contribute a paper at this meeting I felt grave doubts as to my ability to produce one that would be of any service to the members or provoke discussion. In the management of a works of moderate size, where the staff is small, one has little time for research, or even for the systematic recording and classifying of facts, except in the somewhat unreliable receptacle of one's memory.

The ultimate choice of a subject, however, was suggested to me by a recollection of the want I felt of records of similar pieces of work at the time I was called upon to design a gasholder tank to be placed upon a rather awkward site; and I venture to hope that a record of my own experiences may be of service to others in a like position.

The increased demand for gas had rendered the months of December and January periods of continual worry and strain for several years before the directors could be persuaded to face the expenditure of capital necessary to place the storage capacity of the works on a safe footing, and it was late in 1898 before it was decided to put in a new holder. There was a piece of land available in an excellent position in relation to the rest of the works, and, although on the slope of a hill, it did not at first appear to offer any great difficulties in the carrying out of the work.

The first consideration was the size of the holder, and this was governed by the shape and area of the land, which was such that, whatever size of holder was put on it, there would be no room for anything else. It was, therefore, decided to make the diameter of the tank as large as possible, and to put in only one lift of the vessel at present, which would practically double our storage and provide for a good many years to come.

The treacherous nature of the ground in the Isle of Wight is well known to many contractors who have had the misfortune to carry out works in that beautiful but unprofitable district, and possibly had the advice of some of those gentlemen been available at the time some of the difficulties afterwards encountered might have been avoided; but, as a rule, when a job is finished, if not before, they go away, never to return.

A pair of large sewage precipitation tanks had been constructed a couple of years before on the land adjoining the lower side of the proposed site, and by carefully watching the progress of these works it was thought that a fair idea of the nature of the ground had been obtained. In order to get some further information, a trench was cut into the slope on the upper side of the site, which showed a very stiff, yellow clay; and this appeared to stand well. A shaft on the lower side showed similar clay at a depth of about 9 feet, with loose ground above, which was known to have been tipped there when the tunnel on the Ryde railway was made, some 25 years ago.

The choice of materials lay between steel, brick and concrete. At first a steel tank appeared to present many advantages; but on further consideration there appeared to be several serious objections to the use of this material. In the first place, during the construction of the main sewer, it had been observed that the whole of the upper clay had a tendency to slide towards the river, and it would have been necessary to go to a considerable depth to get a foundation of approximately uniform resistance and to obtain a sufficient abutment to overcome the tendency to slide bodily on the greasy surface of the clay. Secondly, although there is no difficulty in designing a steel tank to stand any given bursting pressure, it has little stiffness to resist distortion due to external pressure applied unequally on different parts of the circumference, as would have been the case in this instance, and to stiffen it sufficiently would have greatly increased the cost. These considerations appeared to be fatal to the steel tank.

Between the other two materials there was no difficulty in deciding. The homogeneity and rigidity of concrete, and the ease with which it can be made practically water tight, would have been sufficient to turn the scale in its favor, even had it not been cheaper than brick in cement. The fact that excellent cement is produced within about a mile of the works, and could be delivered by water, and that clean shingle in abundance was obtainable in the Solent and on the Hampshire coast rendered this by far the cheapest method of construction.

In deciding on the thicknees and form of the tank wall and the level of the coping, the slope of the ground was again an important factor. If the tank were placed too low the bank on the upper side would have been unstable; and, on the other hand, as the embankment on the lower side had to be made up it was not safe to rely on it for much support. It was, therefore, decided to make the wall of a thickness calculated to resist the maximum bursting pressure at the bottom, taking into consideration the support due to the solid clay, and to carry it up of this thickness to its full height. There were other advantages in this method of construction that appeared to compensate for the extra quantity of concrete required, viz.: The thickness at the top, 3 feet 6 inches, gave a sufficient base for the steel standards without any piers, and the vertical external surface enabled the concrete to be deposited in the trench against the solid earth, instead of having to form a battered casing and to fill in at the back of it.

The dumpling was originally intended to be a truncated cone with a slope of 2 to 3, covered with a 9-inch casing of concrete. The inlet and outlet pipes were of cast iron, 18 inches diameter, carried up the back of the wall, resting on a single casting forming a drip box, the

horizontal lengths being of steel bedded in the concrete bottom of the tank, which was thickened up at this point.

The contractor commenced work in January by sinking a shaft at the point where the pipes were to be fixed, about 18 feet by 12 feet. This was carried down to the full depth or about six frames with poling boards and 6 inch square walings and struts; and throughout the whole job this never moved. This encouraged the idea that the ground was better than had been anticipated; and the ring was commenced 3 feet 6 inches wide in clear of poling boards with 11-inch by 3-inch walings and 6-inch die square struts, only about 6 bays on the upper side being timbered with 3 inch runners. All went well until about three frames of timber were in on the upper side, which brought the trench about level with the road on the lower side; but, unfortunately, the contractor, anxious to cart away as much as possible before the road was blocked, had been hard at work leveling the interior of the ring, and had also, in making a road for the crane, thrown his surplus soil on to the upper part of the bank. This disturbed the equilibrium of the ground, and the first sign of trouble we had was the appearance of several ugly cracks in the gardens on the other side of the hedge. At the same time the timber on the inner side of the trench began to rise until the struts were some 2 inches out of level, showing that the weight on the outside was lifting the core by fluid pressure. All hands were immediately turned on to remove the earth from the bank and tip it on the inner side of the trench, thus transferring a portion of the weight from one side to the other; and an extra row of walings was put in on the inner side, below the others, with struts raking in the opposite direction to the acquired slope of the original ones.

After several days of constant work, during which some 400 yards of earth were shifted, the movement ceased. This was tested daily for some time by checking the levels of plugs driven into the ground in the gardens above the bank with a point on a building some distance away from the works.

It was found that the timber on the outside had come in about 4½ inches; but this could be got over by cutting out the runners as the concrete was put in, instead of leaving them in. By the time the fourth frame of timber was in on the upper side the runners were well into the solid blue clay, and there was no further difficulty on that side.

But as work proceeded on the southwest side of the ring trouble again commenced. The yellow clay which had appeared so stiff and solid in the trial holes proved to be all alive, and poling boards were no use against it, whilst 11-inch by 4 inch pitch pine walings required 4 struts in a 13-foot bay; which barely left room for the skips to work. There was evidently nothing for it but to put down runners behind the boards, this time on the inner side of the trench, as the pressure was now from that direction. It was also decided to increase the thickness of the wall, as we went down, to about 3 feet 9 inches. It may be mentioned that we had put down bore holes at several points to ascertain at what depth the blue clay would be reached, and finding that on the lower, *i. e.*, west side, it was about 30 feet below coping level, it was decided to carry the wall down 3 feet below the depth originally intended, for some distance round this lower side, in order to get a good abutment to resist any tendency to move bodily. With some 25 feet depth of trench in this semi fluid clay, the trench only 3 feet 6 inches wide, and so much timber in that there was hardly room to move, and the timber men working all night, the time was an anxious one, and every one concerned was so glad when the blue clay was reached and it was possible to bottom up the trench and begin concreting. Under the circumstances it was, of course, impossible to under cut the outer side of the trench, as originally intended, and the concrete had to be placed as soon as a length had been cleared for it Taking into consideration the enormous pressure on the upper side of the tank, which was comparatively unbalanced by any possible resistance we could apply to the rest of the circumference, it was decided to embed rings of railway metals, fished together at intervals as the wall was carried up, with vertical rails to transmit any strain from one ring to another, and the proportion of cement in the concrete was increased from 1 part in 8 to 1 in 7. This was undoubtedly erring on the side of safety, and I have now little doubt that the wall would have stood as originally designed.

The shingle used for the concrete was very clean, and the proportion of sand in it as delivered was exactly what was required to form a compact and impervious concrete. The cement was of remarkably even quality, and in every case far exceeded the specified tests both in fineness and tensile strength.

When the concrete wall was brought up to its full height, it was hoped that our troubles were over, and the excavation of the interior of the tank was proceeded with, the slope of the dumpling being trimmed as the excavation went on. When about 18 feet of earth had been removed below the coping level, one afternoon a slight crack appeared on the levelled top of the dumping, and in about 5 minutes a huge piece had separated itself on a line parallel to and about 3 feet from the north and south diameter of the tank and slid gracefully down, leaving a beautifully polished slope. The whole of this earth was removed, and a bench formed at the bottom of the slip. The batter of the cone was increased and the excavation proceeded with, careful watch being kept for further movements. The top was also concreted over to prevent rain from penetrating and further disintegrating the clay.

In the course of this excavation a most extraordinary geological formation was revealed, which is indicated roughly in the diagram (p. 888). The north and south diameter of the tank appeared to be the anticlinal axis of a singular folding of the beds, which in one place were quite inverted, and it would have been hard to find a more unfortunate site for a tank, though no amount of isolated borings would have revealed this beforehand. These beds appear to belong to the upper Bembridge marls, a portion of the Oligocene strata, which are peculiar to this portion of the British Isles. They are of fluvio marine origin, and are characterized by bands of different colored clays separated by beds of characteristic shells, with occasional bands of stone colored by iron and interlaced with small roots. These shell and stone beds proved fruitful sources of trouble, for they broke up the cohesion of the mass, and further slips took place on the east side of the dumpling, on the joints of these beds. The ultimate section of the tank is shown in the diagram (p. 888) by the parts shaded, whilst the original design is indicated by the parts given in outline. The shape of the dumpling will probably puzzle any engineer who may have occasion to empty the tank at some future time without knowing its history.

As a precaution against further slips, a heavy buttress of concrete, 3 feet wide, was carried up from the bottom of the tank to the center pier, which consisted of a block of concrete 6 feet cube with a cross shaped rest block on the top. Ribs or buttresses were also carried up at four other points, and after the whole was concreted over no further movement took place. The interior of the wall was rendered with cement and sand, 1 to 1, and finished with neat cement killed and worked in with the trowel. The bottom and dumpling were well grouted with equal parts of cement and sand. On filling the tank it was satisfactory to find that it lost only ½ an inch in the first 24 hours; and this by the end of about a fortnight—during which horse dung, hops, and middlings, mixed with cement, were from time to time put in—had diminished to an imperceptible quantity; and though for several months it was possible to detect a slight loss from week to week, the water level now appears to remain practically constant.

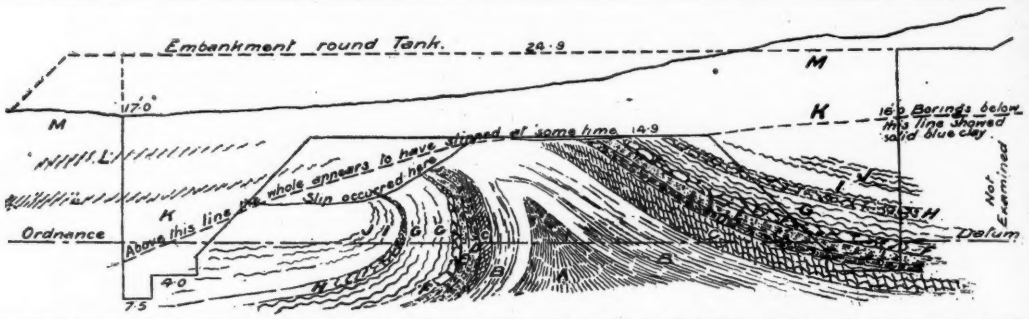
The thickness of the embankment on the lower side was increased, and in this and in the bank above the tank two deep trenches were cut, meeting at the top in the form of a triangle, and filled with large stones, to act as buttresses and drains and lessen the tendency of the banks to slip during wet weather. The whole surface of the slopes all round the bank was covered with about 4 inches of chalk soiled over and sown with grass seed, and a drain was carried round the whole circumference of the path round the tank.

In looking back on the work in the light of the experience gained, one can see many points in which both the design and the methods of carrying it out might have been improved; and it is simply with the object of bringing out such points and drawing forth the opinions and experiences of others that I have ventured to describe the work at such length.

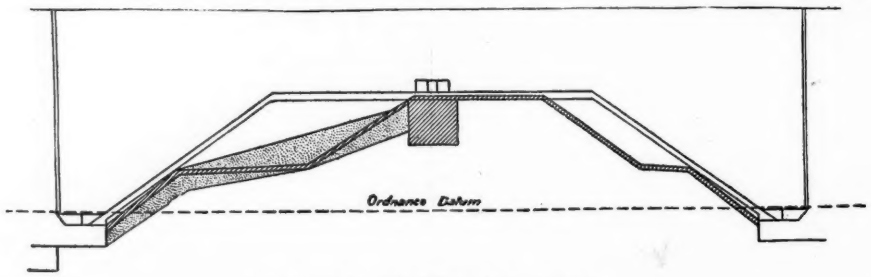
Discussion.

Mr. J. W. Helps said he did not rise to discuss the paper, but merely to thank Mr. Cockey for having prepared it at his request, which was made only three or four weeks ago. He thought the paper was one which would form no inconsiderable additions to the Transactions of the Association. It was of a kind which was particularly suitable to meetings such as theirs, although, perhaps, it did not lend itself to much discussion. It described difficulties that had been met with in the course of everyday work, and he thought that if many members of this and other associations would record their difficulties and the means adopted to overcome them as Mr. Cockey had done, there would never be any difficulty in getting papers for their meetings.

Mr. W. D. Child said although the paper might not be open to much discussion they were obliged for the information which Mr. Cockey had supplied regarding his particular part of the country. He remembered that the late Mr. Garnett, of Ryde, had given an account



A Hard blue clay, no shells. *B* Hard blue clay streaked with purple, shading off into yellow near the surface where moisture had penetrated. *C* Brown clay, no shells. *D* Light green clay, with partings of white sediment ¼ inch thick, with impressions of oyster shells. *E* Brown clay, with layers of shells much crushed. *F* Bed of brown stones, colored with iron and interlaced with black roots. *G* Brownish-green clay, full of paludina, lenta, melania turritissima and cyther:ea (occasional). *H* Bed of stones, similar to *F*, but not so compact. *I J* Yellowish-green clay, with thin beds of small paludina and turritissima. *K* Yellow clay, semi-fluid, with shells scattered throughout, evidently the detritus of the true beds. *L* Beds of peaty earth, evidently old marsh surfaces. *M* Soil and made ground. (The figures on section give height above ordnance datum.)



Section of Tank, as Originally Designed and as Completed.

of the peculiar formation of the soil in that district, and of the measures he had been obliged to take to prevent the slipping of a large mass of earth. In that case, he believed, that at one time the tank itself threatened to slip. Mr. Cockey was to be congratulated upon the energy and resource with which he had tackled his difficulties, and brought the work to a satisfactory conclusion. He was glad to hear that Mr. Cockey had found no difficulty in building a perfectly tight concrete tank. That, indeed, appeared to have been the least of the difficulties with which he had to contend. For his own part he believed that the only difficulty in dealing with concrete was to get the contractor or the contractor's men to perform the work thoroughly and well. If concrete work was cleanly made and properly put in they might rely upon it far more than they had hitherto done, and especially so in tanks.

Mr. Douglas H. Helps said he would like to know if the author had considered the use of expanded metal in the construction of tanks, because by the use of this he thought the quantity of material might be materially reduced. Tests made by Sir Benjamin Baker showed that 5 inch slabs, 6 feet 6 inches apart, strengthened by expanded metal, were ten or eleven times stronger than slabs of the same size without expanded metal. Of course, one would have to consider where the best place was to put the expanded metal. For himself, he thought it should be placed in two positions—as near the outside circle of the tank as possible, and, again, on the inner circle. He was inclined to think that there was a great future for cement work strengthened by expanded metal.

Mr. Thomas Price, Walton-on-Thames, said he had had some recent experience in constructing a concrete tank, and his greatest difficulty had been to get the tank made watertight by rendering it with cement. He thought, perhaps, the soil on which the tank was—viz., yellow clay, had something to do with it.

Mr. Percy Griffith said he had had some experience in these matters, and he thought a concrete tank should compare very favorably as regards both strength and cost with any other form of construction. He had also had some experience in keeping tanks water-tight, both brick and puddle tanks and concrete rendered on the inner face, and that experience showed conclusively that it was far easier to get work carried out with concrete than with brick and puddle; but both puddle and concrete required careful supervision. Still, he thought it was easier to overcome the difficulties which presented themselves in making concrete water-tight than it was with the other construction. He certainly had no difficulty with tanks constructed with rendering so far as their being water tight was concerned. The only difficulty was distinctly due to matters that could have been avoided by stricter supervision.

Mr. J. S. Ineson, Ventnor, coming from the same district as the author of the paper, said he could heartily sympathize with him in his difficulties. The geology of the Isle of Wight seemed to be upside down. In his part of the island the formation was called the "blue slipper," and very appropriately so, for it was continually on the slip. When he saw the Ventnor gas works first, 16½ years ago, one of the gasholder columns was nearly upside down, and the tank was 2 feet 6 inches out of diameter. By perseverance and concrete, however, he brought it to something like a circle, and now it was only about 4 inches out of diameter, and was practically water-tight. In his case he had nothing between him and the sea but the retaining wall.

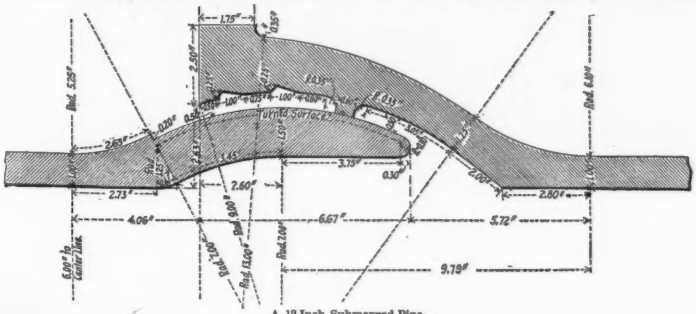
The Chairman, in closing the discussion, said that many of them must have had difficulties in the construction of tanks, and no doubt they would have difficulties again, and a paper such as this would help them very considerably in providing against some of these contingencies. On ground such as they had in the Isle of Wight he thought it would be advisable for engineers to consider whether, in the future, they should not construct steel tanks above ground. At Tottenham he had fortunately a good soil—16 feet of ballast, and below that the London clay, which lent itself admirably to a brick and puddle tank; but in a case such as had been described in the paper, he thought it would be advisable to construct a steel tank.

Mr. Cockey, replying on the discussion, said the main point that he wished to bring out was that this singular construction of the soil could not have been foreseen, and therefore could not have been provided against. He had considered whether he should build a steel tank, but he was very confident that if he had done so it would have slipped away down into the sewage works, or somewhere. He quite agreed that concrete work was simply a question of careful supervision, good clean ballast, and a fair proportion of sand. Fortunately they were able to get a shingle with just about the right proportion of sand in it. The concrete was put down a vertical shoot, and turned over again with sharp tools, so as to work out all the air, which was a very important point. In fairness, he should say that he had no trouble with his contractor; he stuck manfully to the work, although he was losing

money all the time. With regard to the use of expanded metal, he was very anxious to try it in a gasholder tank, but up to now he had not quite seen his way to do so. He should mention, however, that rings of hoop iron 1½ inches by ⅜ inch were bedded in the walls of this tank all the way up. He should very much like to have the opportunity of building a small tank with expanded metal.

A Twelve-Inch Submerged Pipe Line.

Engineering Record reports that a 12-inch submerged pipe line was recently laid across Shirley Gut in Boston Harbor under the direction of Mr. F. A. McInnes, of City Engineer Jackson's staff. The lengths of pipe were put together on shore, then placed on planks supported on rollers, and securely fastened to a hawser in such a way that the strain was largely borne by the hawser. The main is 408 feet long and contains 34 flexible joints. It was pulled across the channel by means of a steam winch, and as the pipe entered the water empty oil barrels were attached to it so as to reduce the friction of the pipe as it was dragged over the bottom. The pipe was placed in a dredged channel about 5 feet deep, and when it was over its final location the barrels were cut loose by a diver. It took an hour and forty minutes to pull the main into place. When tested after the work was done the line was found to be practically tight. The difficulties under which this work was done were unusual, inasmuch as the current in Shirley Gut runs exceedingly fast and the period of slack water is short, about 5 minutes. The pipe used was 1 inch thick, weighing about 1,820 pounds per 12-foot length. It was of special design, the spigot being turned to a true spherical form and a raised ring in the bell or hub being turned to fit the curvature of the spigot; there were two lead scores in the bell. This design causes the lead to remain in the bell in whatever position the joint lies, making the operation of calking a joint under water in the case of a leak comparatively easy.



A 12-Inch Submerged Pipe.

Blower for Portable Forges.

The illustrations show a small hand blower, made by the Champion Blower and Forge Company, of Lancaster, Pa., that has found much favor. An outside view of the fan is illustrated in Fig. 1, whilst Figs. 2 and 3 show clearly its construction. The gearing by which the requisite speed is given to the fan is completely enclosed in an oil and dust tight casing. Keyed to the fan spindle is a worm *A*, which is driven by the worm-wheel *B*, whilst the latter is in its turn rotated by a spur-wheel mounted on the same spindle as the crank handle *C*. The gears are all machine cut, and as ball bearings are employed throughout, the frictional losses are small. The construction of these ball bearings is peculiar, since the balls are mounted in a cage of steel, as shown in Fig. 4. This cage revolves with the balls and serves to hold them together. This is a convenience in overhauling the machine, as the balls are put

Fig. 1.

Fig. 4

Fig. 2.

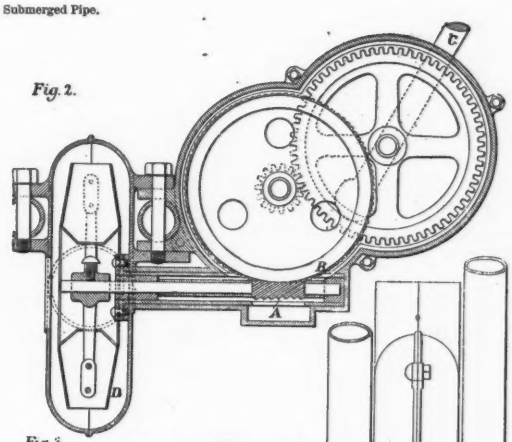
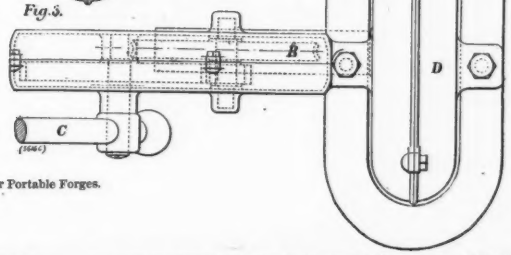


Fig. 3.



Blower for Portable Forges.

in or removed in a batch instead of singly, as with the more usual type of ball bearing. The fan illustrated is 12 inches in diameter and weighs 100 pounds complete, with tuyere iron and piping. The makers claim that the blast from this fan is as steady as from a large power blower, and the wearing parts being either of phosphor bronze or tool steel throughout, the need for repairs should be infrequent.

Notes on the Testing of Modern Dielectrics at High Voltages.

Mr. J. Wright, in discussing this topic in the *Electrical Review*, says: In these days of electric light and power distribution at increasing voltages, the erstwhile familiar phrase of "—megohms per mile," as specifying the quality of the insulating medium or dielectric surrounding a wire or cable, is being rapidly superseded amongst manufacturers, consulting engineers, and others more or less directly concerned in these matters, by the resistance of that dielectric to disruptive discharge, in terms of the number of volts of E.M.F. to which the cable or wire is subjected before being brought into commercial use.

It is obvious, if we regard this matter in a practical light, that the change is materially for the better, and will benefit both manufacturer and customer, in that it denotes the true value of the dielectric as an insulating medium; a rubber insulated wire, yielding an insulation resistance of some hundreds of megohms per mile under a testing E.M.F. of 600 volts continuous, may break down immediately under the application of 600 volts alternating, whereas a fiber or oil insulated main, take, for instance, the Brooks semi-solid system of insulation, though yielding under test only a fraction of a megohm per mile, will withstand a pressure of as much as 20,000 volts alternating without perceptible change. Taking these facts into consideration it is obviously impossible to compare the merits of various dielectrics, or even various qualities of the same dielectric, in terms of megohms per mile, while, on the other hand, by subjecting two entirely different samples of insulating material to a high voltage stressing, or, as it is technically known, "straining," test simultaneously, at regular intervals of their respective "lives," it is possible to judge, with some degree of accuracy, their respective merits.

So important has this matter become, that in many cases specifications for cable contracts lay particular stress upon the resistance of the dielectric to disruptive discharge, the general rule being that it shall be subjected to a testing pressure or voltage at least double that at which it is ultimately intended to work for a certain predetermined period, and (here we have an important point) that the megohmic result obtained after this stressing or straining test shall evidence no perceptible deterioration in the insulating qualities of the dielectric.

To meet the increasing popularity of this form of test all the leading cable manufacturers have for some considerable time now provided the requisite plant for the purpose, such plant usually taking the form of an alternator yielding various low voltages over a convenient range, up to, say, 250 volts, which are then transformed by a suitable transformer, or bank of transformers, up to the required voltage, which may be anything from 1 to 20,000 volts alternating.

In order to undergo the test, the cable, if it be a simple rubber covered core for example, is immersed in a tank of water with its extremities free, for a certain predetermined period, usually some 24 hours. A careful insulation test is taken on it in the usual manner by the direct deflection method, and the secondary (high tension) winding of the transformer is then connected to one extremity of the cable or core, and to the tank, respectively, the latter connection being usually made by means of an earth plate immersed in the water; the remaining end of the cable being left free. The alternator is then gradually speeded up until the voltmeter indicates the required voltage, which is maintained for the requisite period, after which the machine is gradually slowed down. It is better for all purposes to place 2 voltmeters in circuit, one across the terminals of the alternator, and the other (usually electrostatic) between the extremity of the core under test and earth, in order to indicate the exact voltage to which the cable is being subjected. If the multiplying power of the transformer be known, the one instrument then serves as a check upon the other.

It will be noted a few lines above, that special stress is laid upon the gradual slowing up of the alternator after the completion of the test; careful attention to this detail admits of an ordinary insulation test being made shortly after the stressing test. If, on the other hand, the voltage be suddenly cut off, in either the primary or secondary branch it leaves a static charge in the core, which, more especially in a cable of high inductive capacity, tends to interfere with the subsequent galvanometer test, and requires the core to be connected directly with earth for a period proportional to that during which the high voltage was maintained, in order to dissipate itself.

In the case of a lead sheathed or armored cable, the lead sheathing or other metallic covering, of course, takes the place of the water in the tank, thus rendering immersion unnecessary.

One point which has been noted in the stressing or straining of insulated core, especially where the voltage employed approaches that at which the limit of resistance to disruptive discharge is reached, is the apparent accumulation of potential at the points or extremities of the cable, which makes itself evident in the breaking down of the dielectric at the point where it enters or leaves the water, or, if dry, at the point where the lead or other sheathing ends. Various plans have been suggested from time to time to remedy this unfair distribution of potential, and to maintain it uniform at all points of the core. Probably the most likely one to have the desired effect is that of introducing a bank of lamps or other suitable high resistance between the free extremity of the core and earth, the number of lamps or other resistance being proportional to the voltage under application at the time. There would then be a complete circuit for the high voltage, while, at the same time, provided the plant were sufficiently powerful to maintain the potential under these conditions, that difference of potential would still exist uniformly at all points between conductor and earth, and all tendency to accumulation at the extremities would be prevented by the high resistance path to earth. The only drawback to such a plan is the enormous increase of power required, especially in the case of high voltages. High voltage testing under normal conditions, in the case of cables of average inductive capacity, such as quarter-mile lengths of the ordinary 19 or 37 strands, for instance, requires the initial expenditure of anything up to 10-horse power, and that on a blind or condenser circuit, whereas the adoption of a plan of connections, such as the one mooted above, would involve the doubling or even trebling of that output, and this in a factory turning out some hundreds of miles of various types of insulated core in a week, would be a material consideration tending to a general rise in the price of all cables and wires subjected to such tests—a condition of things to be, if possible, avoided.

Another difficulty in the way of successful high voltage testing is the efficient insulation of plant, and this more especially when dealing with voltages of 10,000 and upwards. There is no special design of transformer suited to the exigencies of cable testing, wherefore manufacturers in general have adopted one of the many well known types of transformer on the market, and secured whatever extra insulation they could by insulating the case, oil bath immersion, etc., all of which, though tending to the object in view, viz., the maintenance of a high potential, are highly unsatisfactory in that they are unreliable and open to breakdown at unexpected moments. Taking the question of oil insulated transformers into consideration, it is obviously impossible to build an oil immersed unit of any useful capacity for this type of work without proceeding to impracticable dimensions, whereas with the ordinary air insulated types, unless great care be taken in their construction and erection, constant trouble is experienced in their breaking down at various unexpected points.

What is really required is a highly insulated type of transformer having a capacity of from 20 to 30-horse power, capable of adjustment over a wide range of potential, either by subdivision or otherwise, which will enable voltages varying from 1 to 20,000 to be obtained at all times with perfect security from breakdown.

In the matter of actual testing there is no hard and fast rule as to the real voltage to be applied to any particular class of cable or wire, the general rule being that quoted above, viz., at least twice the normal working voltage; but conditions, of course, vary. With dielectrics of an impregnated fibrous disposition such as jute, paper, etc., the testing voltage may be in terms of the radial thickness of the insulating medium, always provided that the actual nature of that medium remains unchanged. With rubber-insulated core this rule does not apply, but depends to a large extent upon the quality of the rubber employed.

The old time practice of "flashing" the live lead on to the end of the core was altogether an unfair and unsuitable test, in that it imposed enormous momentary potentials due to induction and kindred effects upon the core. The present system of steady application for periods varying from ten minutes to an hour, or even more, forms by far a more suitable method and amply guarantees the insulation of the core. To this end it is frequently specified that such tests shall be carried out like the ordinary galvanometer tests in the presence of the consulting engineer or his representative.

The Evolution of One Electric Light Plant.

By Mr. W. H. Wakeman.

The following description of the installation of an electric light plant and the subsequent changes made in it, is given in order that those who are about to invest in this industry may profit thereby, also for the information of the many people indirectly interested in such enterprises. Answers, of a very practical nature, to many important questions are herein given, applying to plants that are appropriate for cities of say 50,000 to 300,000 inhabitants.

The prime mover in this case was a double engine with cylinders 18 and 20 inches in diameter, the stroke in both cases being 48 inches. It revolved about 80 times per minute, and the power so developed was transmitted by a belt, to a jack shaft in the usual way. No boilers were installed at this time, as it was considered expedient to purchase steam of another company whose plant was located about 1,000 feet distant. The service proved unsatisfactory on account of the large percentage of moisture in the steam delivered, and the cost of the same; but on the whole the plan turned out to be a wise one, in view of the early abandonment of the entire system, and the inevitable loss resulting from disposal of machinery under such circumstances. The double engine with cylinders of different sizes was purchased in order to provide for a varying load. For a light load the 18-inch cylinder was used; when there was more than this could carry economically, the 20-inch was coupled up, and the smaller one laid off; and when all the dynamos were required, both cylinders were used.

This was unsatisfactory for two reasons. It took too long to make the necessary changes; and when they were made, the power developed could not be graduated so as to make the load economical, for when only one dynamo was to be run at perhaps one-quarter of its capacity, the 18 inch cylinder had to be used, and manifestly at a disadvantage. When the load was a little more than this cylinder could carry, the 20-inch would be right; but when the capacity of this was exceeded the load was too light for both, until the full possible output of the station was called for. When we consider that this was at a time when dynamos had not reached their present state of perfection, so far as regulation and other qualifications are concerned, and before the general public had been educated up to the present appreciation of the electric current for light and power, it is not surprising to find that the whole plan was a disastrous failure. The engine was sold for about 35 per cent. of its first cost, and the remainder of the machinery was disposed of for whatever could be secured for it.

Notwithstanding this great discouragement, another plant was soon started, but on an entirely different basis. One large tubular boiler was installed to supply steam for two engines each fitted with a cylinder about 10 inches in diameter, having a 12-inch stroke, with a speed of 280 revolutions per minute. Each engine had two flywheels, and consequently could run two dynamos. From this it will be noted that either one, two, three or four dynamos could be operated, according to the amount of current called for by customers; and that the changes could be easily and quickly made. The boiler was calculated to carry a high pressure; and as it was located near the engines, the steam was dry. Besides the cost of steam was less on this account because there was no profit made on it by a second party.

As the service was satisfactory, and the returns were sufficient to warrant it, other engines of the same kind were added, until more than a dozen, some of them larger than the pair already mentioned, were installed. Tubular boilers were used for several years, but after a time the company was induced to try a water tube boiler, of a type which has since come to be considered superior to all others for the purpose, and has been substituted for the fire tube boilers formerly used.

As soon, however, as the plant had attained these large proportions, an unforeseen trouble appeared that cost the proprietors much money to remove; the plant, although located very near the business center of the city, was nevertheless in the immediate vicinity of some fine residences, the owners of which strongly objected to having their slumbers disturbed at all hours of the night by the noise of escaping steam from the exhaust pipes of so many high speed engines. It is plain, to all who have noticed the conditions, that the exhaust steam from a high speed engine makes more noise than that from one running at a slower speed. This is due not only to the greater number of puffs that appear in a minute, but also to a tendency to draw the air into the exhaust pipe between the puffs, provided the terminal pressure in the cylinder is below the atmosphere. When the exhaust valve opens under these conditions, air is drawn in to raise the pressure to correspond to that of the outer air; and when the next puff is expelled against this inward action, the result is a muffled report, the rapid continuation of which is very annoying.

Under the varying conditions found here, these engines were not balanced, and the vibration caused by them made a continual disturbance that could not be tolerated. Complaints were made that demanded attention; and in order to overcome the objections, exhaust heads were used to remedy the first mentioned nuisance, and extensive foundations to obviate the latter one, but these were only partially successful, and it gradually became evident that a part of the whole of the plant must be moved to some more favored locality. To the site then occupied it was necessary to cart the coal about a mile; and as it was the same distance to the nearest river, water for condensation was not available; therefore it had been necessary to run the plant non-condensing, which made it much more expensive. Another site was purchased, located on the bank of a river at a place convenient to unload coal barges, thus reducing the cost of fuel per ton and the number of tons required to run the plant.

Several facts in this connection are very significant. One is that while the old engines were far from being worn out, they were not removed and set up in the new station, but were sold; and engines of a type entirely different from those previously used were purchased instead. The new engines were tandem compounds in rather small units, as the high pressure cylinders are 12 inches and the low pressure 22 inches in diameter, with a stroke of 36 inches. Long main belts are used to transmit power to a jack shaft nearly as long as the building, and this is made in sections so that any part of it may be run at pleasure. By the aid of one small, high speed engine it is possible to get almost any required combination of prime movers, so that the size of the same may be adapted to the given load.

As an abundance of water is at hand, the plant is run condensing, thus obviating the noisy exhaust pipes; and as there is but one-third the former number of engines, and they run but 100 revolutions per minute, vibration is eliminated.

Moreover, the plant is located in a neighborhood where there are now few residences—one that will not be thickly populated for many years to come and probably never will be overcrowded, owing to the nature of the locality.

This seems to give a combination of conditions that are at once pleasant and profitable; but the cost of making the change was very great in proportion to the size of the plant.

The old power plant has never been entirely abandoned, and still contains a fraction of the apparatus previously installed there. It might never have been built at all had the owners secured their present experience without it; and it is safe to say that if others will carefully consider all available locations when about to erect plants to furnish light and power, and will take into due consideration all the surroundings, much annoyance and heavy expense may be avoided. It will also be noted that the engines used are neither high nor low speed, but are a happy medium between the two extremes.

Atomic Weight of Radium.

In a communication recently made to the Académie des Sciences, M. Curie states that he has succeeded in making an approximation toward the atomic weight of the new element radium. Since the commencement of his researches for isolating the new element, the progress of its concentration in the chloride of barium has been constantly observed by the study of the spectrum and determinations of atomic weight. Each time that the treatment of the mineral gave a new quantity of the chloride, this was submitted to a systematic series of crystallizations in order to give a small quantity of a product as concentrated in radium as possible. A part of this was treated with hydrochloric acid to give a very pure product, which M. Demarçay has found by the last series of spectrum analyses to contain only traces of barium, and may be considered as an almost pure chloride of radium. The quantity of pure salt isolated in this way is insufficient, however, to obtain the atomic weight of radium, and M. Curie, in his last determinations, used the product containing a larger proportion of barium, of which he had 6 grains. A determination was made at the same time upon pure chloride of barium as a check. After indicating the process used for finding the atomic weight of each product, M. Curie states that the weight found for barium gives the number 138, and that of the product containing radium, 174.1 and 173.6 in two cases. There is no means of finding the relative amount of radium and barium in the latter product, but M. Demarçay concludes from the

spectrum that there is a greater proportion of radium. It is, therefore, certain that the atomic weight of radium is much greater than 174. The quantity of pure chloride of radium isolated is not sufficient to allow the study of the properties of this element in a pure state, but its existence is no longer a matter of doubt.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, NOV. 10, 1900.

Clockwork and Gas Consumption.—Electricity a Failure for Public Lighting.—The Prospects of American Coal in England.

An interesting example of the way in which history repeats itself is afforded by the re-introduction of clockwork in connection with the consumption of gas. One of the earliest attempts to improve upon the contract system of supplying gas, or the plan of sending round inspectors to turn the service cock on or off, was the adoption of a clockwork device to the main tap, in such a way that it was started when the tap was turned on, and stopped when the tap was shut off. It thus indicated the number of hours that the tap was turned on and the gas presumably in use. Lately an elegant design of this arrangement has been put on the market, not for the service tap, but for use in connection with gas fires or burners in hotels, lodgings, flats, etc. By this means the lodger can have the use of a gas fire for any period, long or short. A charge per hour being agreed upon, it is a simple matter, when he is leaving, to note the number of hours and charge the same at the agreed rate. From the cost of this device, however, it is not a wide step to that of a small meter, which, public opinion to the contrary, is likely to afford a more correct indication of the actual consumption. If the tenant uses the fire only half on, for example, he cannot slow down the clock in proportion, and the seconds are reckoned up to his credit ex actly as when the fire is full on. But I have lately been testing a little clockwork contrivance that has a most promising future, assuming that its mechanism proves reliable under all weathers. This is an accessory to the ordinary street lamp, intended to be used with a by-pass pilot light, or a self-lighting burner. An arrangement of the good old 8 day clock kind is provided with a brass disk geared to revolve once in 24 hours, with perforations at every hour. A kind of brass finger, or pawl, can be clamped to any hour in such a way as to engage with a specially arranged plug head to the tap, and "turn on the gas" at the hour desired. A similar contrivance, acting independently of the first, is provided for shutting off. In place of the daily visits of the lamplighter, this arrangement only requires attention once a week. when the clockwork is wound up, and the time of lighting and extinguishing adjusted according to the season of the year. For example, this week it is set to light at 5 and extinguish at 6, because lighters start at 4:15 and 6 respectively. There is not only a saving in wages but a saving in gas. When the lighting hour is 5 o'clock, there must not be many lamps left to light after that hour, and the lighter, to do his average hour's run, must start not later than 4:15. The same happens with regard to extinguishing. He must not start very much before the prescribed hour, and there is always a little friction in the streets that are lighted last or extinguished first. The effect of lighting or extinguishing at one moment—in practice the apparatus acts within two minutes of the prescribed time—means a saving of one hour per day, which really comes to an economy of no less than 10 per cent. of gas. In these days, when electricians are prepared to take the street lighting at prices considerably below actual cost for the sake of the advertisement thus secured, a feather of very much less weight may turn the scale in favor of the gas. If the present test of this apparatus warrants, I propose to try it on an extended scale. The party who introduced the apparatus to my notice was a stranger, and I have no interest in the device beyond that common to all managers of gas works, which is a reduction of expenses in proportion to work effected or service rendered. It can be manipulated to start at odd quarter or half hours if desired.

A friend sends me a copy of the *Municipal Journal*, which by the way affords interesting reading in regard to the question of municipal trading or ownership. The number under notice contains references to new streets, art schools, crematoriums, telephones, the supply of sterilized milk, docks, the housing of the poor, electrical notes, working a coal mine, instruction in habits of cleanliness, and the best methods of utilizing food, technical education, tramways, poor law, the extermination of rats, refuse destruction and public parks, from which it is evident that the qualifications necessary for membership of a municipal authority are both numerous and varied. But the only matter which concerns us at present, is the paragraphs under the heading of "Electrial Notes," which are a revelation, when we remember the claims that have been advanced in favor of electricity as compared with gas, to the effect that the advantages afforded by its use were so obvious and prominent that the rapid displacement of gas for all and every purpose was a matter of certainty. The troubles brought about by failures of electric light are discussed at considerable length. But the principal item to which I wished to direct attention is an extract from a report to the Maidstone Corporation by Sir W. H. Preece, who is not likely to be suspected of prejudice in favor of gas. This gentleman says: "The streets are now so well lighted, and at such a cheap rate, by the Welsbach incandescent mantle that I question very much the advisibility at first start of adopting glow lamps to replace the gas lamps. The glow lamps are not so brilliant as the incandescent gas and cost much more. * * * You are paying £2 18s. 3d. per lamp per annum for gas. It will cost you £6 per annum to light equally well with glows, and the satisfaction given will not be commensurate with the extra cost." Sir W. H. Preece is perfectly clear on the point that an equal light to that afforded by incandescent gas cannot be supplied by electricity at more than double the cost, but is somewhat ambiguous as to the "satisfaction" afforded by introducing the electric light. People are always prejudiced in favor of novelties, and believe it is good policy to encourage competition, provided that such can be done with some benefit to themselves. But beyond that the idea of electricity possessing more intrinsic excellence that renders it, light for light, preferable to gas, is ridiculous and absurd. This point has been too highly labored by electricians, wtth the result that the pendulum is now swinging the other way. The novelty of the thing has worn off, and people are beginning to ask whether the wonderful superiority claimed for electricity is founded upon anything more than imagination. The result is that the present season is witnessing the displacement of electric lighting to a very large extent, by the incandescent mantle, simply because the consumer believes that the latter is not only a cheaper but a better light. Especially is this the case where the gas companies are prepared to relieve the consumer of the responsibility of keeping his burners in order. Another extract will afford further explanation on this point.

"The unsatisfactory nature of the electric light supply in the City of London still continues, notwithstanding the prospective competition. An astounding statement has just been made to the Corporation by Mr. Veysey, the electrical engineer, in his annual report. He points out that within the past 12 months there have been nearly 1,000 lamp failures * * * the Corporation is still without the means of testing the value of the supply to the public lamps. * * * The inspector was advised during 1899 of two important interruptions in the supply to private consumers * * * defects in the pressure of supply occurred on 11 different occasions." If this is the case in the City of London, and under the pressure of competition, we may agree with Sir W. H. Preece that the satisfaction given by the adoption of the electric light is not commensurate with the extra cost. It is evident that such is the opinion of many who have already tried it.

Nor is the Metropolis the only place where the electric light is causing dissatisfaction. At York the streets have been in darkness on more than one occasion lately, and a member of the Corporation has moved a resolution to the effect that notice should be sent to the gas works, when necessary, so that the gas lamps may be lit when the electric light is not available. At a recent meeting of the Chelmsford Town Council, complaint was made as to the inefficient state of the public lighting, and one councillor expressed the opinion that the town did not get a fair return for the money so spent. The town clerk was instructed to write to the electric company, and this roused the suggestion that such a course would be useless.

Mr. C. Carpenter, chief engineer to the South Metropolitan Gas Company, has published a few particulars of the working results obtained from the cargo of American coal referred to in last month's letter. The yield of gas, after correction to standard temperature and pressure —60° and 30"—was 10,550 cubic feet and the quality 16½ standard candles. This is equivalent to 4.71 cubic feet per pound of coal. The coke was very good, hard and close grained, and the sales over the weighbridge were 11¼ cwt. per ton. Adding the quantity used as fuel, this would give a make of about 14 cwt. The production of tar and ammoniacal liquor was similar to that from Durham coal, but the tar was rather more viscous. The coal is very clean and free from sulphur and is readily handled in inclined retorts set at 32°. From these details it would appear that the American coal is fairly comparable with an average Yorkshire or Lancashire gas coal. The best brands of Newcastle coal give more gas and a larger yield of coke. As is the case with many of our English coals, the quality of the gas is not

sufficiently high to enable enrichment in some form or another to be dispensed with. On the score of purification and yield of tar there is some advantage, but the experiments do not support the claim of a marked superiority, which has been put at as high as 50 per cent. as compared with average English gas coal. Nor do they offer any inducement to pay a higher price. So that unless the American coal can compete in the matter of cost, it is not likely to be used to any large extent in English gas works. There are some towns on the South Coast which are even more unfavorably situated than London as regards the cost of coal, and where the scale would consequently be turned in favor of the American article to the extent of a shilling or two per ton. On the other hand, there is a general concensus of opinion that the boom in the coal trade is about played out. Things are now very quiet. The autumn season has been a very mild one and consumers have laid in large stocks. One of the artifices by which prices have been forced up and maintained during the summer has been the creation of a scare respecting the coal supply of the coming winter. The public press has as usual taken the bait and assisted the coal factor in his desire to sell coal at famine prices during the summer, by writing articles on "How will the poor get on at Christmas with coal at £3 per ton," and such like exciting but improbable topics. The result is that not only household cellars, but gas makers, steam users and all large consumers of coal have stocked heavily, and many will not require to buy again until we have experienced some weeks of winter weather. The representatives of coal factors are on the war path, and there is a surprising willingness to pile up arrears of deliveries. The only thing that can prevent an immediate and considerable fall in coal values is a prolonged spell of severe weather. These arrears of delivery are a very convenient weapon for lifting large quantities of coal off the market, and thus keeping prices stiff. The clauses usual in coal contracts are now so elaborate that there is no difficulty in finding some excuse for holding back delivery, and then when the quiet time comes, the coal merchant can consent to "oblige" his customer, by carrying out his contract.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES

At the annual meeting of the Ogdensburgh (N. Y.) Gas Company the Directors chosen were: Henry A. Sage, W. N. Bell, R. E. Waterman, J. Y. Chapin and Louis Richter.

The J. S. Rogers Company is to construct the new office building of the South Jersey Gas, Electric and Traction Company, of Camden, N. J. As was heretofore noted in the JOURNAL the building is to be located on Federal street.

It is reported that the Board of Trustees of the village of Clyde, N.Y., have granted a franchise to Mr. Charles A. Lux for the operation there of a gas, electric and steam plant.

The American Steel Hoop Company is going to put in steel bins at its Isabelle furnaces, Aetna, Pa. This will require about 750 tons of steel, which will be furnished from one of the Pittsburg plants of the American Bridge Company. The bins will be made in accordance with the design of Mr. Julian Kennedy, M.E.

The proprietors of the Ashtabula (O.) Gas Company have commenced injunction proceedings against the city authorities to prevent them from enforcing an ordinance adopted some short time since fixing the selling rate at 60 cents per 1,000 cubic feet. There is little doubt that the courts will eventually declare that the price named in the ordinance is an unreasonable one.

At the semi-annual meeting of the Directors of the Portland (Me.) Gas Light Company a dividend of 3 per cent. was declared out of the earnings for the past six months. It is payable January 2d, 1901.

A special meeting of the shareholders in the Cincinnati Gas Light and Coke Company is called for the 20th inst., to vote upon a proposition for increasing the capital stock in the sum of $500,000—the present capitalization is $9,000,000. The new stock will be issued to shareholders of record in proportion to their holdings at par. The proceeds of the sale are to be largely devoted to main extensions to and through the outlying suburbs of Hartwell, Hyde Park and Evanston.

The City Gas Inspector for Omaha, Neb. (Mr. Gilbert), reports that the public gas lamp service is fully up to every requirement named in the contract.

A correspondent forwards the following, under date of November 26th: "Acting upon the recomendation of a special committee, the City Council of Springfield, Ohio, has adopted an ordinance governing the Springfield Gas Company's dealings with its customers. Under the terms of the instrument the Company may not charge to exceed $1 per 1,000 cubic feet; no meter rentals may be charged, and service connections from mains to meters are to be made at the Company's expense. The agreement is to last for 10 years. This is a substantial victory for the Company, as many of the extremists in the Council were clamorous for a rate of 75 cents."

Mr. John Zehner, Sr., for many years proprietor of the Tamaqua (Pa.) Gas Company (in fact he controlled that property for upwards of 35 years, parting with his interest therein to the present Citizens Gas Light Company, of Tamaqua in 1883) died at his home in Tamaqua the morning of 19th ult. Deceased was in his 77th year.

Consul Hughes, of Coburg, says that in Austria, where everything in the shape of fuel is being carefully investigated, sawdust is impregnated with a mixture of tarry substances and heated to the proper temperature. It is then passed over a plate of iron heated by steam, from which a screw conveyor takes it to a press, where it is compressed into briquettes of the required size. The press turns out 19 per minute, weighing two-fifths of a pound each, and measuring 6 by 2½ by 1½ inches. The caloric power is about the same as that of lignite, with but 4 per cent. of ash. One factory produced last year over 7,000,000 briquettes, costing about 16 cents per 1,000, and selling at from 95 cents to $1 per 1,000.

We understand that Morning Sun, Iowa, is to have a gas plant of the acelytene type, which is to be installed by Messrs. A. W. Dawson & Co., of Mason City, Iowa.

The gain in output by the Peoples Gas Light and Coke Company, of Chicago, for the first 9 months of the current year, compared with the corresponding period of 1899, is returned at well over 11½ per cent.

Considerable activity has been shown of late in the shares of the Toledo (Ohio) Gas Light and Coke Company, the trading having been accomplished at figures well in advance of those last recorded.

There is quite a contest on for the right to supply gas in Wyandotte, Wayne county, Mich., a bustling, busy place on the Detroit river, and on the Lake Shore and Michigan Southern Railroad, at a point 12 miles southwest of Detroit. The Union Gas Company, which is said to be controlled by those of interest in the Detroit Gas Company, agreed to furnish, in their petition to the Council, crude natural gas at the rate of 50 cents per 1,000 cubic feet for all purposes, or to furnish purified natural gas for 85 cents per 1,000 cubic feet, or to furnish a high candle power artificial gas at $1.20 per 1,000 cubic feet. Messrs. August Loeffler and William Gartner agreed in their application to furnish a high candle power artificial gas, at the rate of $1.40 per 1,000 cubic feet for an illuminating use, and at the rate of $1.25 per 1,000 cubic feet on fuel account, the city to receive in return for the franchise 5 cents per 1,000 cubic feet sold per meter account. Another speculator, named Theodore Megges, has affirmed his determination to submit a proposition. A special meeting of the Council was called for last Tuesday, with the purpose of considering the various propositions; but we have not been advised as to what was then done. There cannot be any doubt that a gas works would be a paying institution in Wyandotte.

Messrs. J. B. Woodruff and others are anxious to establish a gas plant in Blue Island, Ills., a place on the Calumet river about 15 miles south of Chicago. It is quite a manufacturing center, and has a population of not less than 5,000. The projectors agree not to charge in excess of $1.25 per 1,000 cubic feet, but the authorities seem disinclined to sanction a charge over $1 per 1,000.

We understand that the authorities of Durham, N. C., have awarded a 50-year franchise for the operation of a gas works there to Mr. A. M. Sutherland, of New York, and his associates. Durham is 26 miles northwest of Raleigh, and, aside from its historic relations to the War of the Rebellion, because of its importance as a manufacturing center, is well worthy of the attention of business men on the line suggested by Mr. Sutherland. Its population is not less than 7,500, and it is a certainty that its growth is of the permanent sort.

(*Concluded on page* 894.)

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
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CHAS. E. SANDERSON,
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AGENTS:

New York—American News Co. 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, DECEMBER 3, 1900.

(*Continued from page* 893.)

CONTRARY to the thought of a few, who would like to engage the Fresno (Cal.) Gas and Electric Light Company in another chapter of opposition, its proprietors have no idea of advancing the rate charged for gas.

CHIEF ENGIEEER BYRNE, of the Kings County Gas and Illuminating Company, of Brooklyn, N. Y., is quite satisfied with the working of his inclined retort installation.

AT a special meeting of the Board of Directors of the Baltimore Consolidated Gas Company, held last Monday, the resignation of Mr. Bernard Cahn as a Director was offered and accepted. The vacancy was at once filled by the election of Mr. Charles H. Dickey.

IT is likely that in due time Mr. Dickey will be elected Vice-President of the Company, which position also carries with it the Chairmanship of the Executive Committee. Mr. James A. Gary, the present Vice-President, is anxious to retire from these positions, owing to the routine work imposed by them. In fact, he wished to retire from the Board of Directors, but his fellow members would not listen to his voice in that respect.

THE proposition submitted some time ago by the syndicate of New York and Baltimore capitalists for control in the Baltimore Consolidated Gas Company, was rejected. This may not be taken to mean in any sense that the parties after the plant have decided to abandon their attempts to purchase it.

MR. FRED. J. MAYER, the capable managing engineer for Messrs. Bartlett, Hayward & Co., sailed for Europe last Tuesday. He will be abroad something over two months.

THE hearing before the Board of Gas and Electric Light Commissioners of Massachusetts, on the petition of certain residents for a reduction in the rate charged by the East Boston Gas Company, will be resumed next Wendesday.

THE authorities of Providence, R. I., have determined evidently to give public lighting by means of Welsbach lamps a good trial, for the Committee on Lights of the City Council reported recently in favor of the proposition submitted by the Welsbach Street Lighting Company. The report was subsequently adopted by the Council. The Welsbach proposition among other things, said: "We will furnish, complete, and attach to present gas posts in use, standing and connected to mains, or which may hereafter be erected and connected, 675 more or less, and as many as may be required, up to 1,000, of our improved 60 candle power Welsbach street light fixtures and boulevard lanterns, similar to those furnished by us to the City of Boston; furnish labor, residents of your city, to light, extinguish, clean and do all the necessary work in connection with the lamps; keep lanterns and fixtures in repair, lights to burn all night, and every night in each year, for the following price: For the term of 6 years, from January 1, 1901, for the sum of $30 each per light per annum, this price to include every item of expense in connection with the installation and operation of the lanterns and fixtures. We will in addition furnish bond in the sum of $5,000, guaranteeing that each of said lights shall be of not less than 80 per cent. of the rated candle power at any time during the entire term of the said contract, and will agree to comply with the conditions and requirements for lighting the streets, lanes, public ways and grounds of the city, as shall from time to time be imposed by the city."

THE maximum candle power that the Company agrees to furnish is 60.

MR. L. A. BERTHOLF has been appointed Superintendent of the Newark (N. Y.) Gas, Light and Fuel Company.

THE bears had quite a successful innings recently in depressing the ruling quotations for shares in the San Francisco Gas and Electric Company. Their high card carried the story that Mr. Claus Spreckels proposed to construct and operate a gas works in connection with his electric lighting scheme.

THE projectors of the Hawthorne and North Paterson (N. J.) Gas Company are persisting in their attempts to secure a franchise that will enable them to enter into competition with the Paterson and Passaic Gas and Electric Company. They offer to sell gas at 80 cents per 1,000 cubic feet. They have not a possible chance of success.

THE local authorities of Woodstock, Can., are seriously considering the taking over of the plant of the Woodstock Gas Light Company, for operation on public account.

IMPORTANT betterments are being made upon the plant of the Town of Hempstead Gas and Electric Light Company, of Far Rockaway, L. I.

MR. E. G. HOLZER, formerly Manager and Superintendent of the Peoples Light, Heat and Power Company, of Phillipsburg, N. J., has accepted a position with the Easton (Pa.) Gas Light Company. His successor at Phillipsburg is Mr. W. O. Brown, of Port Jervis, N. Y.

The Market for Gas Securities.

The Consolidated Gas Company has declared a quarterly dividend of 2 per cent., "out" of the earnings of the corporation. The further earned increment remains untouched. The dividend is payable the 15th inst. The stock was quite steady during the week, and the closing to-day (Friday) was made at 194½ to 195. Considerable disappointment was shown over the failure of the "three" to put out a Christmas present, but as all things come to those who wait, it is reassuring to know that the "three" won't have it all in due process of nature.

Brooklyn Union shows no change, but all indications point to strength in it rather than weakness. Peoples, of Chicago, is well above par, and Baltimore Consolidated more than maintains its position towards better figures. Mr. C. H. Dickey, has been elected a Director in the Company, and further indications are that he will be named its Vice-President. The Cincinnati Company proposes to increase its capital in the sum of $500,000. It is in good demand at better prices, as it should be in accordance with the stock proposition.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

DECEMBER 3.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$54,595,200	100	194½	196
Central Union, Bonds, 5's.	3,000,000	1,000	106	107½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	120	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	298	306
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. ..				
Bonds, 5's	11,000,000	1,000	103¼	109
Northern Union, Bonds, 5's.	1,250,000	1,000	104	104½
New York and East River .				
Bonds 1st 5's	3,500,000	1,000	103	108½
" 1st Con. 5's	1,500,000	..	115	.
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	130	138
Preferred	5,000,000	100	150	158
Bonds, 1st Mortgage, 5's	1,500,000	1,000	110	114
Yonkers	299,600	500	180	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	175	180
" " Bonds (5's)	15 000,000	1,000	116	119
Bay State	50,000,000	50	1	1¼
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	24	26
" 1st Mtg. 5's	475,000	1,000	98½	99½
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7	9
" " Bonds, 5's	5,250,000	1,000	68	71

Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,550,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	191	192
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,682,720	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	105
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	59½	60
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	16
" Con. Mtg. 5's	880,000	1,000	80	85
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,560,000	50	95	97
" Prior Lien 5's	4,598,000	1,000	99½	100
Detroit Gas Co., 5's	386,000	1,000	100	101
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co.	1,000,000	50	105	107
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	240	250
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	72	82
" Bonds, 6's	2 650,000	..	98	100
Jackson Gas Co	250,000	50	70	75
" 1st Mtg. 5's	250,000	1,000	101	103½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	101½	102
Laclede, St. Louis	7,500,000	100	71½	73½
Preferred	2,500,000	100	35	100
Bonds	10,000,000	1,000	107	107½
Lafayette Gas Co., Ind.	1,000,000	100	35	40
Bonds	1,000,000	1,000	60	65
Louisville	3,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	68	75
" 1st Mtg. 6's	350,000	1,000	103½	108
Montreal, Canada	2,000,000	100	182	184½
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,800,000	..	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	101⅛	101⅜
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	30,100,000	1,000	90¾	91
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co	1,500,000	100	47	05
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,493,000	1,000	88	90½
St. Joseph Gas Co	1,000,000	100	31	34
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	9	10
Bonds	1,612 000	1,000	88½	93
Washington, D. C	2,800,000	20	273½	278½
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	100	95	98
Bonds, 5's	3,880,500	..	107	107½
Wilmington, Del.	600,000	50	200	201

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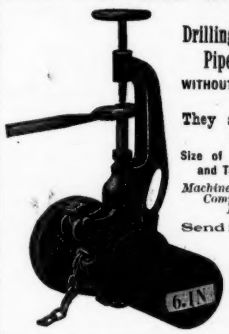

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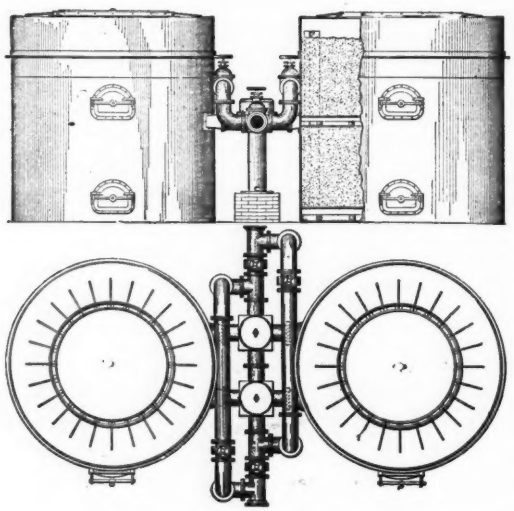

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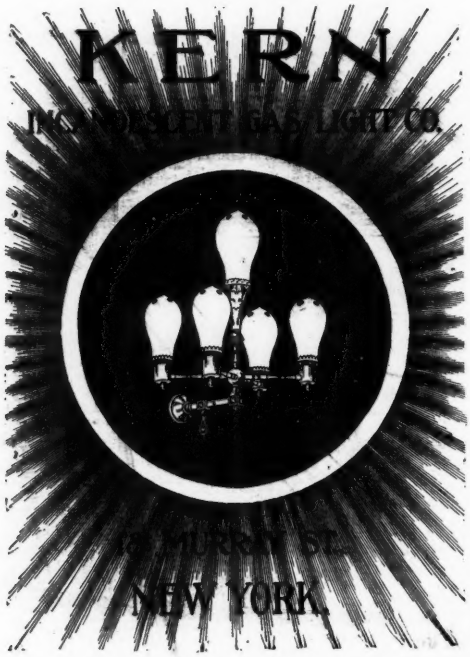

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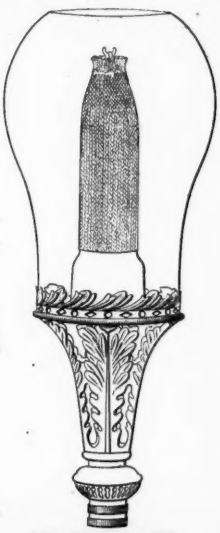

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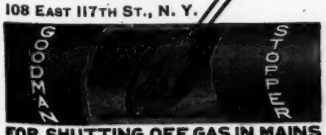

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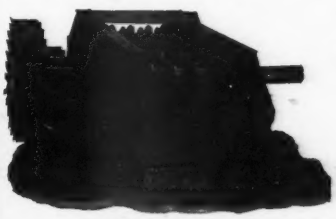

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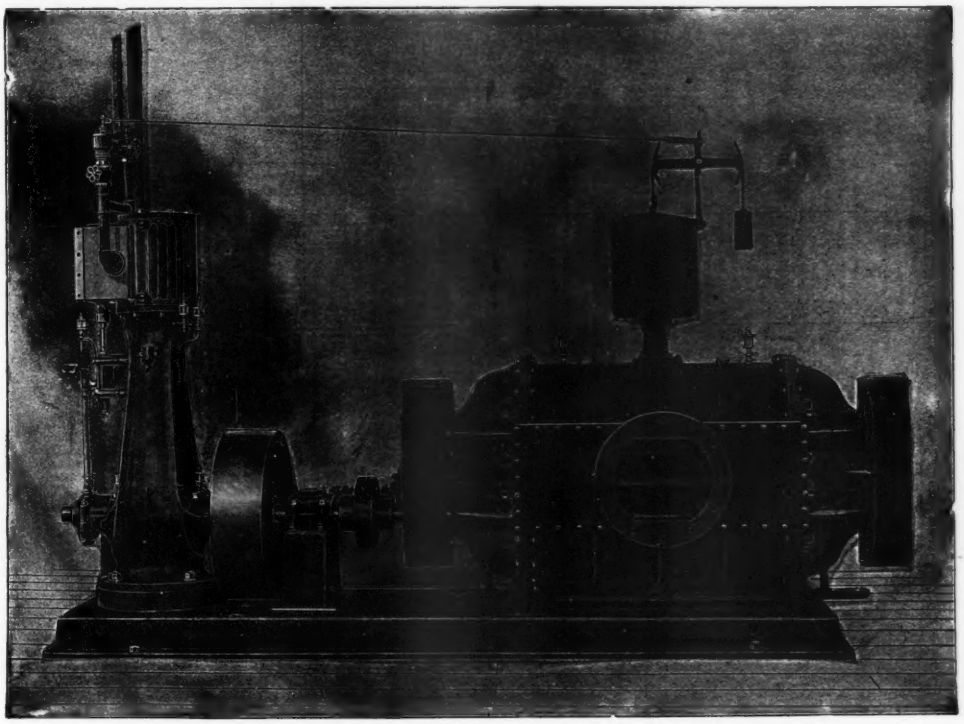

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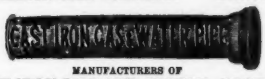

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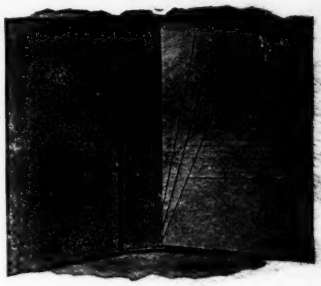

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Work Done for Several of the Largest Gas Companies in America Stands as Reference.

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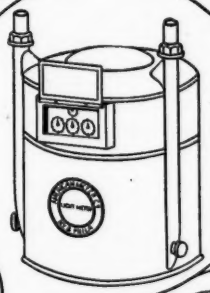

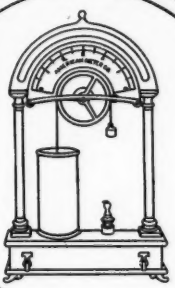

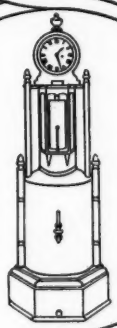

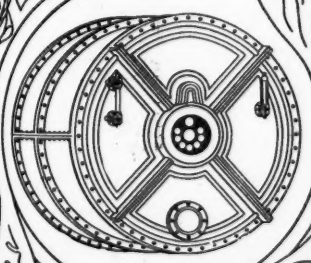

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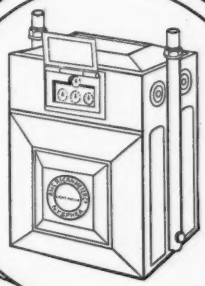

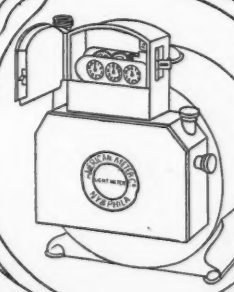

PUBLIC LIGHTING TABLE.

DECEMBER, 1900.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sat.	1	1.30 AM	6.00 AM	4.20	6.10
Sun.	2	2.40	6.10	4.20	6.10
Mon.	3	4.00	6.10	4.20	6.15
Tue.	4	No L.	No L.	4.20	6.15
Wed.	5	No L. FM	No L.	4.20	6.15
Thu.	6	No L.	No L.	4.20	6.15
Fri.	7	5.00 PM	7.00 PM	4.20	6.15
Sat.	8	5.00	8.10	4.20	6.15
Sun.	9	5.00	9.10	4.20	6.15
Mon.	10	5.00	10.10	4.20	6.20
Tue.	11	5.00	11.10	4.20	6.20
Wed.	12	5.00	12.10 AM	4.20	6.20
Thu.	13	5.00 LQ	1.10	4.20	6.20
Fri.	14	5.00	2.10	4.20	6.20
Sat.	15	5.00	3.00	4.20	6.20
Sun.	16	5.10	4.00	4.20	6.20
Mon.	17	5.10	5.00	4.20	6.20
Tue.	18	5.10	6.20	4.20	6.20
Wed.	19	5.10	6.20	4.20	6.20
Thu.	20	5.10	6.20	4.20	6.20
Fri.	21	5.10 NM	6.20	4.20	6.20
Sat.	22	5.10	6.20	4.20	6.20
Sun.	23	5.10	6.20	4.20	6.20
Mon.	24	5.10	6.20	4.20	6.25
Tue.	25	5.10	6.20	4.20	6.25
Wed.	26	9.00	6.20	4.20	6.25
Thu.	27	10.10	6.20	4.20	6.25
Fri.	28	11.20 FQ	6.20	4.20	6.25
Sat.	29	12.30 AM	6.20	4.20	6.25
Sun.	30	1.40	6.20	4.20	6.25
Mon.	31	2.50	6.20	4.20	6.25

TOTAL HOURS LIGHTING DURING 1900.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	230.50	January	423.20
February	175.40	February	355.25
March	189.00	March	355.35
April	160.30	April	298.50
May	150.40	May	264.50
June	137.00	June	234.25
July	152 00	July	243.45
August	171.50	August	280.25
September	187.20	September	321.15
October	213.10	October	374.30
November	221.50	November	401.40
December	231.50	December	433.45
Total, yr.	2221.40	Total, yr.	3987.45

NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

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.... OF AMERICA ....

No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

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Uniformly SUCCESSFUL in seventy-five Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

No. 38.

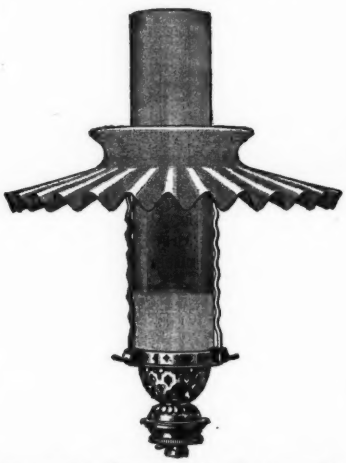
Correspondence solicited from Gas Companies and others interested in Municipal and outside lighting.

Welsbach Famous Mantles.

THE INCOMPARABLE

YUSEA Welsbach MANTLE

FINEST EXAMPLE OF INCANDESCENT GAS LIGHT EVER EXHIBITED.



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THE HIGHEST ILLUMINATION, The Lowest Cost.

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WELSBACH COMPANY,

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Chicago Branch Department and Supply House, - - - - - 70 Wabash Avenue.

THE UNITED GAS IMPROVEMENT COMPANY.

THE STANDARD DOUBLE SUPERHEATER LOWE WATER GAS APPARATUS.

CONTRACTS RECEIVED SINCE JANUARY 1, 1900.

	SETS.		SETS.
DANSVILLE, N. Y.	1	HACKENSACK, N. J.	1
WEST CHESTER, PA.	1	TIFFIN, O.	1
COHOES, N. Y.	2	MOUNT HOLLY, N. J.	1
OGDEN GAS CO., CHICAGO	1	SEATTLE, WASH.	1
CENTRAL UNION GAS CO., NEW YORK	1	TARRYTOWN, N. Y.	1
SPENCER, MASS.	1	HOBOKEN, N. J.	2
SAN FRANCISCO	1	PATERSON, N. J.	2
BROOKLYN UNION GAS CO., BROOKLYN	1	NEWARK, N. J.	2
RICHMOND, VA.	2	JERSEY CITY, N. J.	1
CAMBRIDGE, MASS.	2	AUSTIN, TEX.	1
CARBONDALE, PA.	1	ELIZABETH, N. J.	1

NUMBER OF SETS	28
TOTAL SETS INSTALLED TO JANUARY 1, 1900	327
TOTAL SETS INSTALLED TO DATE	355
TOTAL DAILY CAPACITY	227,000,000 Cubic Feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
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H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

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Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

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Fire Brick Manufg. Co.,

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FIRE BRICK . . .
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Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

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By WALTER RALPH HERRING.

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Proprietor,

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Works, Weber, N. J.

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(ESTABLISHED 1855.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

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OFFICE, 418 to 422 East 23d St., N. Y.

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Fire Brick, Tiles, Etc.

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A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

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In Kegs, 100 to 200 " " 6 " "
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MANUFACTORY AT

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JOHN DELL,
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INSPECTION AND ADVICE.

PLANS AND ESTIMATES
FOR IMPROVEMENTS OR
REPAIRS.

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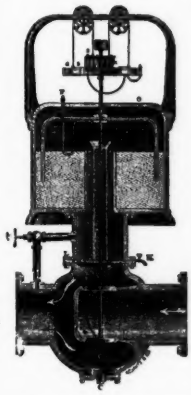

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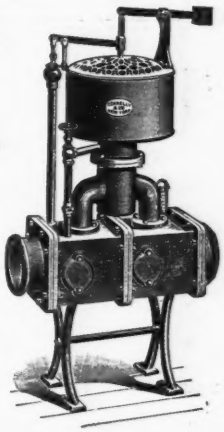
BALANCE GAS GOVERNORS.
"Iron Sponge" and Natural Oxide
FOR GAS PURIFICATION.
EXHAUSTERS, ETC.



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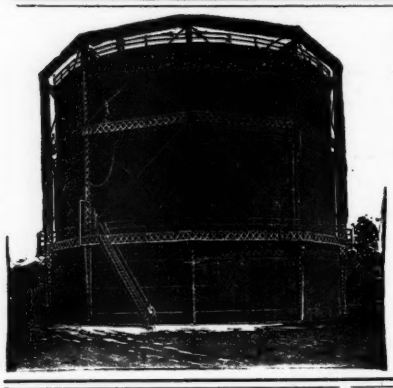

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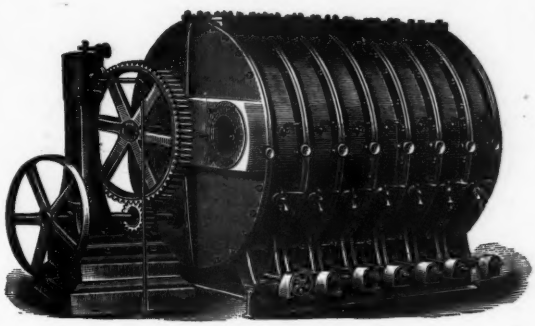

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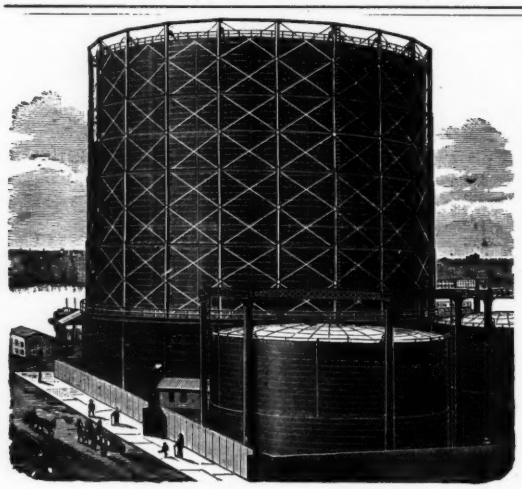

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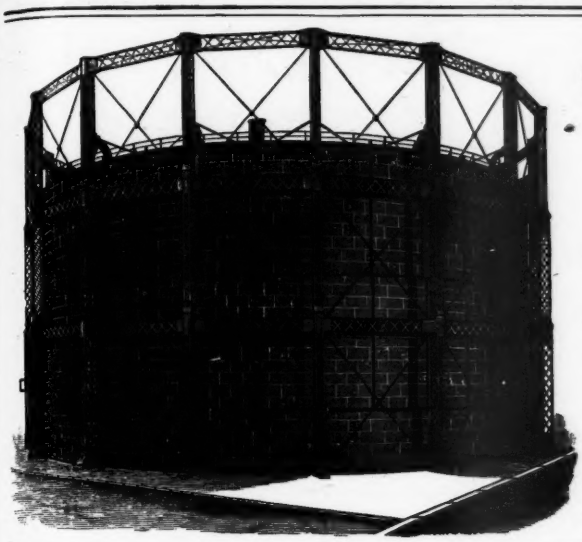

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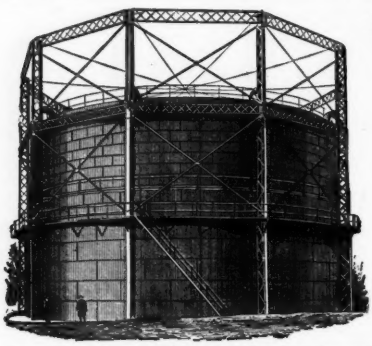

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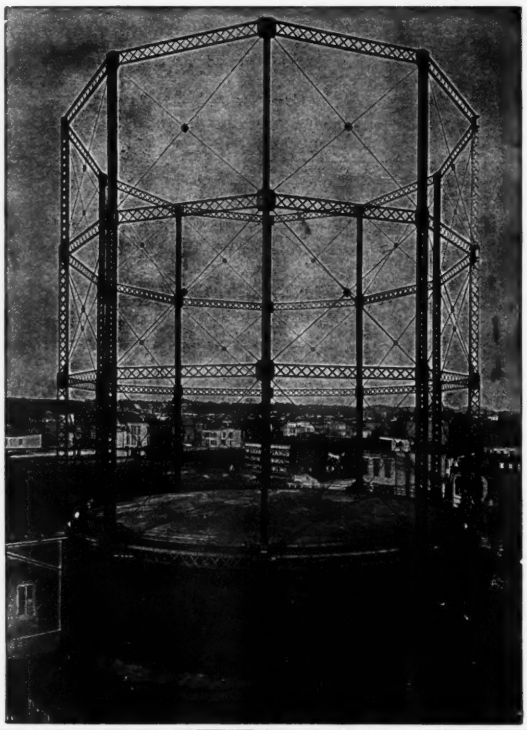

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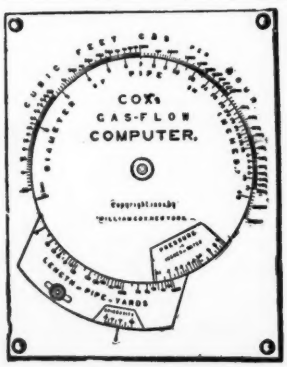

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